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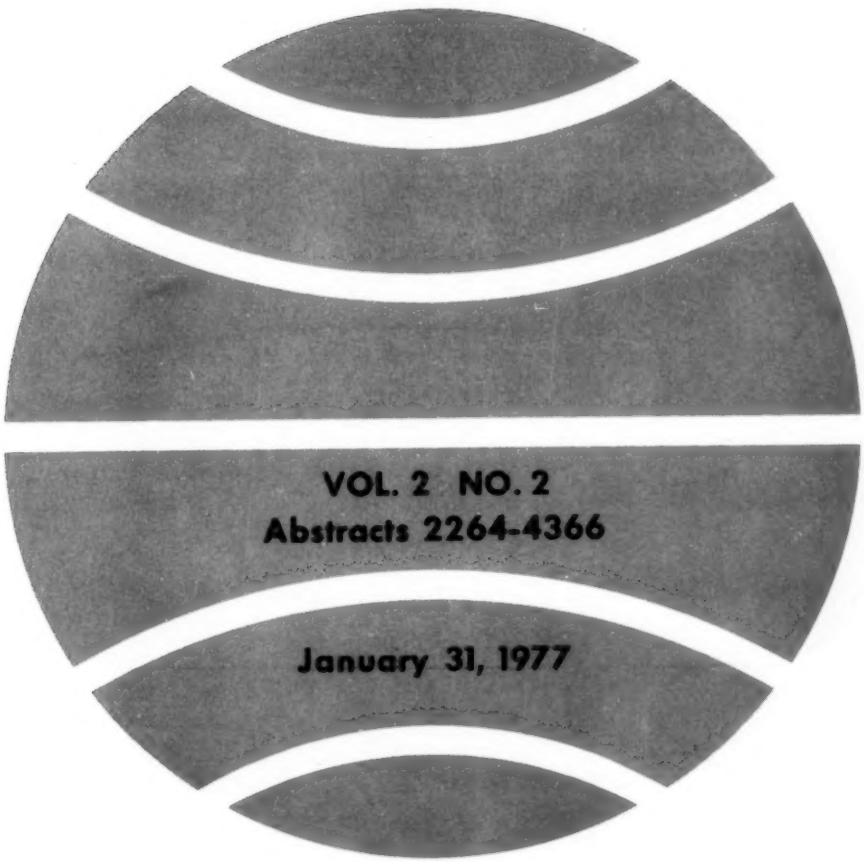

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ERDA ENERGY RESEARCH ABSTRACTS

COAL AND COAL PRODUCTS

REFER ALSO TO CITATION(S) 3331

PROCESSING

2264 (FE—2027-1) **Materials, process, product analysis of coal process technology. Phase I final report.** Saxton, J.C.; Roig, R.W.; Loridan, A.; Leggett, N.E.; Capell, R.G.; Humpstone, C.C.; Mudry, R.N.; Ayres, E. (IR and T, Arlington, Va. (USA)). Feb 1976. Contract E(49-18)-2027. vp. Dep. NTIS $10.50.

The purpose of materials-process-product analysis is a systematic evaluation of alternative manufacturing processes—in this case processes for converting coal into energy and material products that can supplement or replace petroleum-based products. The methodological steps in the analysis include: Definition of functional operations that enter into coal conversion processes, and modeling of alternative, competing methods to accomplish these functions; compilation of all feasible conversion processes that can be assembled from combinations of competing methods for the functional operations; systematic, iterative evaluation of all feasible conversion processes under a variety of economic situations, environmental constraints, and projected technological advances; and aggregative assessments (economic and environmental) of various industrial development scenarios. An integral part of the present project is additional development of the existing computer model to include: A data base for coal-related materials and coal conversion processes; and an algorithmic structure that facilitates the iterative, systematic evaluations in response to exogenously specified variables, such as tax policy, environmental limitations, and changes in process technology and costs. As an analytical tool, the analysis is intended to satisfy the needs of an analyst working at the process selection level, for example, with respect to the allocation of RDandD funds to competing technologies.

CARBONIZATION

REFER ALSO TO CITATION(S) 2311

2265 (FE—1220-12) **Clean coke process: process development studies. Report for the first quarter, 1976.** (USS Engineers and Consultants, Inc., Pittsburgh, Pa. (USA)). May 1976. Contract E(49-18)-1220. 24p. Dep. NTIS $3.50.

General maintenance was completed on the carbonization PDU; in addition, a new pipe heater was installed to replace the General Electric recycle-gas heater, which had developed leaks at the outlet nozzle because of stress-corrosion cracking. The carbonization PDU was operated in a 10-day 1325°F run, to produce 1866 pounds of char. The char, carbonized at residence times of 47, 96, and 157 minutes, contained 0.80, 0.70, and 0.63 percent sulfur, respectively. The new heater performed satisfactorily, and there was no evidence of carbon deposition. Total PDU operating time is 1920 hours, with 1059 hours at 1300°F and higher. The flash vaporizer of the binder-preparation PDU was operated to process blowdown wash oil from the carbonization PDU. Shakedown runs were continued to establish operating procedures for the continuous distillation column. The pelletizing equipment of the coke-preparation PDU was used to produce 225 pounds of green pellets from process char and a pitch/creosote binder. These pellets exhibited excellent stability after they were cured and calcined. Revisions were made in the hydrogenation PDU to enable testing with solids-containing oil. Hydrogenated tar oil containing Synthoil residue in concentrations of 4 to 6 percent solids was used in successful vapor-stripper operation. Preparations were subsequently made for operation of the coal-hydrogenation reactor.

2266 **Clean coke process: fluid-bed carbonization of Illinois coal.** Johnson, T.F.; Krupinski, K.C.; Osterholm, R.J. (U.S. Steel Corp., Monroeville, PA). *Am. Chem. Soc., Div. Fuel Chem., Prepr.*; **20**: No. 4, 33-45(1975).

From 170. American Chemical Society national meeting; Chicago, Illinois, USA (24 Aug 1975).

See CONF-750806—P2.

The Clean Coke process is being developed by United States Steel Corporation under contract with ERDA's Office of Coal Research to provide a means for utilizing the nation's abundant reserves of low-grade, high-sulfur coal to produce metallurgical coke, chemical feedstocks, and liquid and gaseous fuels. The basic process combines low-temperature carbonization of coal and hydrogenation-liquefaction of coal to provide an energy- and hydrogen-balanced process; all operations are conducted in closed loops, which eliminate either escape or discharge of pollutants to the environment. Results are summarized of studies on carbonization of Illinois No. 6 seam coal in a fluidized bed to produce low-sulfur char. The carbonization char is subsequently combined with a process-derived liquid binder to form green pellets, which are then cured and finally calcined to produce metallurgical coke pellets. This study includes results on the effects of carbonization variables--temperature, pressure, reaction time, and feed pretreatment--on the desulfurization reaction and on operation of the fluid-bed carbonizer. Under optimum conditions, coal containing 2.3 percent S was carbonized to produce a char containing less than 0.5 percent S.

2267 **Formcoke preparation in clean-coke process.** Shoenberger, R.W. (U.S. Steel Corp., Monroeville, PA). *Am. Chem. Soc., Div. Fuel Chem., Prepr.*; **20**: No. 4, 46-69(1975).

From 170. American Chemical Society national meeting; Chicago, Illinois, USA (24 Aug 1975).

See CONF-750806—P2.

An important phase of the Clean Coke Process is the production of high-quality metallurgical coke from processed low-sulfur char, and heavy residual oils. Because bench-scale exploratory tests have shown that a strong coke could be produced by a pelletization-carbonization method, investigations were continued to develop this process. A summary of the bench-scale investigations using a simulated char produced at the U.S. Steel Research Laboratory, and simulated binders obtained from various sources, is presented. Green pellets of good quality and desired size were produced from Illinois coal char by using several coal tars or asphalt binders in a disc pelletizer. These green pellets were pretreated in bench-scale tests by curing in air to 500°F, or by preheating in an inert atmosphere to 900°F in 1-$^1/_2$ hr at fast rates by using $^1/_2$- by $^1/_4$-in. coke as a supporting medium. The pretreated pellets were then carbonized to 1850°F in 2-$^1/_2$ hr. By such procedures, excellent coke pellets of 2- by $^3/_4$-in. size were produced that were equivalent in cold strength properties to metallurgical coke. Pelletization, pretreatment, and carbonization steps are being optimized to design a 4 tph pilot test.

2268 **Manufacture of metallurgical formed coke according to the BFL-HOT briquetting process.** Ahland, E. (Bergbau-Forschung GmbH, Essen); Lehmann, J.; Peters, W.; Langhoff, J. *Am. Chem. Soc., Div. Fuel Chem., Prepr.*; **20**: No. 4, 70-84(1975).

From 170. American Chemical Society national meeting; Chicago, Illinois, USA (24 Aug 1975).

See CONF-750806—P2.

Since 1962, Bergbau-Forschung GmbH of Essen developed, in cooperation with the Lurgi Mineraloltechnik GmbH of Frankfort, a process for the continuous production of formed coke, i.e., the so-called "BFL Process." By this process a uniform formed coke is made by means of hot briquetting of two components. Its utilization in the technical scale has been tried successfully in several blast furnace tests for periods up to 7 days. With this process, most of the input coal, i.e., 70 to 80 percent, may be non-coking coals, and only a rather small proportion of the input coal, i.e., 20 to 30 percent, must have as binding coal a certain behavior of softening and a certain coking power. By the development of this process, the coal basis for the production of metallurgical coke as against the conventional coke production in vertical flue ovens is enlarged essentially. As the entire process takes place in closed equipment, the more and more important demand for a prevention of dust emissions during coking is fulfilled to a high extent. After the development work had been carried out successfully for several years in the laboratory, in the small-technical scale and in a 5 t/h plant, Ruhrkohle AG of Essen established during the years 1973/74 a large-scale testing plant with a daily throughput of 300 tons. This plant is being put into operation at present. It will serve to establish, on the one hand, practise-near quantitative and heat balances of the BFL process, thus solving questions of the economy of the process, and, on the other hand, to produce sufficient quantities of formed coke for long-time tests in the blast furnace.

DESULFURIZATION AND PURIFICATION

REFER ALSO TO CITATION(S) 2266

2269 (FE—2028-2) Kinetics and mechanism of desulfurization and denitrogenation of coal-derived liquids. Second quarterly report, September 20, 1975—December 20, 1975. Katzer, J.R.; Gates, B.C.; Olson, J.H.; Kwart, H.; Stiles, A.B. (Delaware Univ., Newark (USA)). 8 Jan 1976. Contract E(49-18)-2028. 90p. Dep. NTIS $5.00.

The construction of the first high-pressure liquid-phase flow microreactor has been completed, and kinetic studies of reaction of dibenzothiophene have been started. Understanding of catalytic hydrodesulfurization and catalyst decay has been advanced by examination of the reaction rate of thiophene, tetrahydrothiophene, and butanethiol on Harshaw 0402T catalyst. Two batch autoclave reactors have been completely assembled behind appropriate safety barricades; satisfactory operation has been demonstrated; and quinoline hydrodenitrogenation studies are underway to demonstrate operating procedures providing quantitative, reproducible data. Quinoline rapidly hydrogenates to tetrahydroquinoline; the two compounds appear to be in thermodynamic equilibrium. The tetrahydroquinoline apparently undergoes slow hydrogenolysis of the nitrogen-containing ring giving n-propylaniline as an identified long-lived product. The reaction engineering of the pulsed microreactor system has been developed and compared to some laboratory data. The moments of the inlet and exit pulses show substantial effects from product adsorption.

2270 Laboratory evaluation of properties of fly ash-iron oxide absorbents for H_2S removal from hot low-Btu gas. Oldaker, E.C.; Poston, A.M. Jr.; Farrior, W.L. Jr. (Morgantown Energy Research Center, WV). *Am. Chem. Soc., Div. Fuel Chem., Prepr.*; **20**: No. 4, 227-237(1975).

From 170. American Chemical Society national meeting; Chicago, Illinois, USA (24 Aug 1975).

See CONF-750806—P2.

Results of research toward the development of a solid regenerable sorbent for the removal of sulfur from hot (1000 to 1500°F) producer gases are discussed. Powdered iron oxide and fly ash mixed with a suitable binder, extruded into $^1/_4$-in. by $^3/_4$-in. cylinders and sintered, provided a solid sorbent with good physical strength and absorption capacity for hydrogen sulfide, while withstanding temperatures to 1500°F without harm. Physical strength of the sorbent was increased without reducing absorption capacity when either bentonite or sodium silicate was used as a binder. Optimum sintering conditions were 1800°F for 30 min. in an oxidizing atmosphere. The maximum amount of iron oxide that could be added to the fly ash-iron oxide sorbent was 25 percent because of the surface area and heat resistance of the support material. Tests using 1500 scfh of raw producer gas showed that tars and particulates in the producer gases did not cause any ill effects to the sorbents as long as the temperature in the absorbed bed was maintained above 1000°F. Buildup of carbonaceous material during absorption was burned out during regeneration of the sulfided sorbents. Regeneration of the sulfided sorbents was accomplished by passing air through the sorbent bed returning the $FeS.FeS_2$ to Fe_2O_3 and producing an 11 to 12 percent SO_2 concentration in the effluent gas. Temperatures reached 2000°F momentarily while the highly exothermic reaction was taking place. Using air diluted with nitrogen reduced these temperatures to 1500-1600°F thus protecting the life expectancy of the sorbent although the time required for regeneration was increased and SO_2 concentration was decreased.

2271 Investigations on the removal of hydrogen sulfide at high temperature from coal gas. Murthy, K.S. (Battelle Columbus Labs., OH). *Am. Chem. Soc., Div. Fuel Chem., Prepr.*; **20**: No. 4, 238-252(1975).

From 170. American Chemical Society national meeting; Chicago, Illinois, USA (24 Aug 1975).

See CONF-750806—P2.

Results of absorption and regeneration experiments performed in a fixed bed tubular quartz glass reactor are described. Problems associated with severe hydrogen sulfide (H_2S) attack at high temperature on stainless steel types 304 and 446 are defined. Desulfacity (g of H_2S absorbed by 100 g of sorbent charge) data on more than eight different sorbent combinations are compared. The regenerability of these sorbents utilizing air is described. Size analyses of sorbents before and after one cycle of absorption-regeneration tests are presented. In light of the definable properties and performance characteristics of ideal desulfurizing sorbents, a discussion of the actual performance of the sorbents tested is presented. Thermodynamic considerations of sorbents for high-temperature H_2S removal are discussed. Advantages of high-temperature H_2S removal versus low temperature sweetening of coal gas are defined. Recommendations are made for an overall research and development program necessary to achieve successful commercialization of the new technology. During the course of this experimental study, a sorbent combination with good potential for commercial use has been developed. This sorbent has exhibited good absorption-regeneration characteristics with excellent physical strength.

2272 Solvent refining for clean coal combustion. Wolk, R.; Stewart, N.; Alpert, S. *EPRI J.*; **1**: No. 4, 12-16(May 1976).

Solvent refining removes sulfur and particulates from coal by the use of hydrogen in a reaction system at elevated temperature and pressure. In this process, a substantial portion of the coal is dissolved by an internally generated solvent. Particulates are removed by filtration or other methods. About 70 percent of the sulfur is converted to hydrogen sulfide and filterable iron sulfides. The end product, a liquid under reaction process conditions, is cooled to an essentially ash-free solid of reduced sulfur content that is useful as a fuel for power generation. A critical matter is the rate of solvent generation. It must be "balanced" to provide the solvent needed to slurry new coal entering the process, despite the cracking of the solvent to lower boiling liquids and gaseous products.

HYDROGENATION

REFER ALSO TO CITATION(S) 2306, 2313, 2314, 2315, 2317, 2331

2273 Differential scanning calorimetry studies on coal hydrogenation. Mahajan, O.P.; Tomita, A.; Nelson, J.R.; Walker, P.L. Jr. (Pennsylvania State Univ., University Park). *Am. Chem. Soc., Div. Fuel Chem., Prepr.*; **20**: No. 3, 19-22(1975).

From 170. American Chemical Society national meeting; Chicago, Illinois, USA (24 Aug 1975).

See CONF-750806—P1.

Differential scanning calorimetry in conjunction with the thermogravimetric analysis technique has been used to determine quantitatively thermal effects involved during hydrogenation of 21 U.S. raw coals of varying rank at 800 psig and temperatures up to 570°C. The heat of hydrogenation decreases with increase in coal rank; exothermic heats vary from 153 cal/g for lignites to 6.9 cal/g for anthracite. Transition temperature, that is the temperature corresponding to the onset of exotherms, is markedly dependent on coal rank, varying from about 250°C for lignites to 540°C for anthracite. A sharp increase in transition temperature occurs for coals having a carbon content, on a dry-ash-free basis, in the 75 to 80 percent range. In most cases, demineralization of coals decreases the heat of hydrogenation. However, in the case of medium volatile and HVA bituminous coals, exothermic heats increase upon demineralization. There is some indication that pyrite, or pyrrhotite produced during reduction of pyrite, may have a beneficial catalytic effect on coal hydrogenation. Reaction rate constants have been estimated in some cases. In general, demineralization causes a decrease in rate constant and an increase in activation energy for hydrogenation.

2274 Product of flash hydrogenation of Illinois No. 6 coal. Graff, R.A.; Dobner, S.; Squires, A.M. (City Coll., New York). *Am. Chem. Soc., Div. Fuel Chem., Prepr.*; **20**: No. 3, 23-33(1975).

From 170. American Chemical Society national meeting; Chicago, Illinois, USA (24 Aug 1975).

See CONF-750806—P1.

Rapid heating of coal in hydrogen at elevated pressure gives improved yields of light aromatic liquids provided the vapor product residence time is neither too long nor too short. Product yield structure is given for Illinois No. 6 coal heated at a rate of 640°C/sec in 100 atm. of flowing hydrogen. After reaching a preselected final temperature the sample is maintained at this temperature for 10 sec. A residence time between 0.18 and 5 sec has been provided for the vapor products. At 0.6 sec, in the temperature range 600 to 950°C, a maximum in the yields of both BTX (benzene+toluene+xylene) and ethane is observed at about 800° C. Beyond 850°C the only substantial vapor products are methane, ethane, and benzene. Below this temperature increasing amounts of toluene, xylene, and heavier species are observed. The influence of heating rate, solids contact time, and vapor residence time is illustrated by yields in experiments where these parameters have been varied. For example, increasing the vapor residence time to 3 sec at 700°C, increases the BTX yield and substantially eliminates species heavier than xylene.

2275 **Reactivities of heat-treated coals in hydrogen.** Tomita, A.; Mahajan, O.P.; Walker, P.L. Jr. (Pennsylvania State Univ., University Park). *Am. Chem. Soc., Div. Fuel Chem., Prepr.*; **20**: No. 3, 99-102(1975).

From 170. American Chemical Society national meeting; Chicago, Illinois, USA (24 Aug 1975).

See CONF-750806—P1.

Reactivities of eighteen, 40 x 100 mesh, U.S. coals charred to 1000°C have been measured in H_2 at 400 psig and 980°C. Chars prepared from low rank coals are generally more reactive than those derived from high rank coals, although in some cases reactivities are significantly higher than those predicted from rank. Reactivity parameters for the chars in H_2 are different from those measured for the same set of chars in air at 500°C and CO_2 at 900°C. Results indicate specificity in catalytic behavior of mineral matter associated with chars towards gasification in oxidizing and reducing atmospheres. Reactivities have also been measured for chars prepared from six coals acid-washed with HCl and four coals demineralized with HF. Partial or complete removal of mineral matter, in most cases, decreases char reactivity; higher reactivities observed in some cases have been attributed to modification of pore structure of chars upon mineral matter removal. Effect of hydrogen pressure and reaction temperature on reactivity has been investigated for one lignitic char. An apparent activation energy of about 44 kcal/mole was obtained for this char. Effect of particle size on reactivity of a lignitic char and a low volatile bituminous char are discussed.

GASIFICATION

REFER ALSO TO CITATION(S) 2326, 2327, 2328, 2329, 2338, 2346, 2954, 2957, 3332, 3591

2276 (AED-CONF—75-521-002) **Summary report on coal gasification.** Franke, F.H. (Rheinische Braunkohlenwerke A.G., Koeln (Germany, F.R.)). 1975. 2p. (In German). (CONF-7510127—1). INIS.

From Seminar on modern methods of gas production and of the use of gas in power engineering; Wuppertal, German, Federal Republic of (F.R. Germany) (2 Oct 1975).

16 figs. Available from ZAED.

By means of numerous illustrations, a total survey of the actual problems in coal gasification is given. The following problems are outlined: a) The basic conversions, the kinetics, the energy demand, b) the conventional German and American processes, c) the nuclear coal gasification process now under discussion, d) the schematics of test plants under construction, e) economical considerations and estimates as well as f) main research topics.

2277 (CONF-760838—1) **Current status of the BI-GAS process.** Young, R.K. (Bituminous Coal Research, Inc., Monroeville, Pa. (USA)). 1976. Contract E(49-18)-1207. 18p. Dep. NTIS $3.50.

From 3. annual international conference on coal gasification and liquefaction; Pittsburgh, Pennsylvania, United States of America (USA) (3 Aug 1976).

Activities currently in progress at the pilot plant, or at BCR in support of the pilot-plant program, include process studies in the coal preparation area, particularly on coal and char flow measuring systems; preparation for phased operations of the gasifier; installation of a complete on-line data acquisition system; experimental work in slag viscometry for the purpose of studying various coal and coal flux mixtures; modifications of our computer simulator to provide specific data for operations with start-up coal; and, finally, preparations for an environmental sampling program to be conducted by a subcontractor under the guidance of Phillips and BCR.

2278 (FE—1505-6) **Liquid phase methanation. Quarterly report, October 1, 1975—December 31, 1975.** (Chem Systems, Inc., New York (USA)). 1975. Contract E(49-18)-1505. 48p. Dep. NTIS $4.00.

Bench scale work focussed primarily on the effect of direct steam addition to the synthesis gas fed to LPM/S reaction. The addition of steam increases the overall reaction rate by promoting the water gas shift reaction and providing hydrogen for the methanation reaction and increases the exit gas H_2/CO ratio. There appears to be an optimum level of steam addition, after which the effect of dilution by unreacted steam results in reduced productivities. Two different Engelhard catalysts were tested. Both exhibited low initial activity and further activity loss after only 30—50 hours. Neither is a viable catalyst candidate. The LPM/S life test unit operating on a 1.40/1 H_2/CO feed gas was terminated after 550 hours due to a plug in the reactor inlet. The probable cause was overheating of the liquid phase in a dead zone below the gas inlet. The reactor was modified to allow premixing of the gas and liquid streams. The activity level of the Calsicat Ni-230S/Witco 40 system was consistent with previous results. A second run on a 1.4 H_2/CO feed gas was terminated after 235 hours due to a power failure. A backup temperature limit control system was installed to prevent a recurrence of this problem. The polishing reactor life test was terminated as planned after being on-stream for 1000 hours. The product gas composition remained constant over the range 60—61 percent CH_4, 39—40 percent CO_2 with trace H_2 and CO. Work on the pilot plant neared completion. Approximately 200 piping welds on the LPM pilot plant were radiographed by an independent inspection firm. Of these, 30 percent were considered defects according to the ANSI-31.3 code. The remaining 300 welds are being radiographed and should be completed by the end of January. At that time, the defective welds will be repaired and the rest of the pilot plant check-out performed.

2279 (FE—1514-47) **Advanced coal gasification system for electric power generation. Quarterly progress report, January—March 1976. Third quarter, fiscal year 1976.** (Westinghouse Electric Corp., Lester, Pa. (USA). Heat Transfer Div.). 2 Jun 1976. Contract E(49-18)-1514. 54p. Dep. NTIS $4.50.

Two devolatilization tests were conducted to explore devolatilizer operability over a range of operating conditions using a low-sulfur, mildly caking Indiana coal from the Minnehaha mine of Amax Coal Company. In the first test the system was operated for over 30 hours at temperatures of 1400 to 1800°F and at a pressure of 225 psig with a fluidized bed of char. An analysis indicated that about 94 percent of the volatile matter in the coal was removed. Some fixed carbon was gasified as a consequence of the water vapor content in the inlet gases. The second test provided additional steady-state data on heat and material balances, char characteristics and reactor system operation. Reactor operation was sustained for over 12 days and produced reliable design data. Support work was carried out to investigate operating conditions for the PDU test program, provide troubleshooting capability for PDU operation, obtain data for PDU modifications, analyze and interpret results from PDU operation and develop information for future process development. The coal behavior test program was directed toward obtaining devolatilization data as a function of coal particle size and tests on coals used in the PDU tests. Two tests were run with Canaan dolomite to study its resistance to disintegration resulting from thermal shock in charging, from temperature cycling in the bed, and from partial calcination. Work on solids transport, the intermediate scale test facility and reactor analysis was carried out. Limited gas turbine combustion experiments with oil and low Btu gas are reported. (LTN)

2280 (FE—1521-20) **Development work for an advanced coal gasification system for electric power generation from coal directed toward a commercial gasification generating plant. Phase II, quarterly technical progress report, April—June 1976.** Smith, D.E. (Foster Wheeler Corp., Livingston, N.J. (USA)). Aug 1976. Contract E(49-18)-1521. 60p. (FWC/FWEC/GQ—06). Dep. NTIS $4.50.

Design drawings and specifications were issued for numerous components of coal gasification pilot plant and commercial plants. The flow behavior and entrainment of solids injected into cold flow models were studied further. With a modified configuration, improved entrainment was obtained. The development of models of gas and steam turbine operation was continued, particularly with respect to transients during off-design operation and the control systems required. (LTN)

2281 (FE—1770-12) **Computer modeling of coal gasification reactors. Quarterly technical progress report, January 1,**

1976—March 31, 1976. (Systems, Science and Software, La Jolla, Calif. (USA)). 15 Apr 1976. Contract E(49-18)-1770. 37p. (SSS-R—76-2909). Dep. NTIS $4.00.

The purpose is to develop and apply an accurate and general computer model that will expedite the development, and aid in the optimization and scale-up, of fluidized beds and entrained flow reactors for coal gasification. Initial applications will be to high-BTU, fluidized-bed gasification processes. Later the work will be extended to consider low-BTU, fluidized-bed gasification, entrained flow reactors and fluidized-bed combustion. After the final testing of the 1-D thermomechanical code, some simple experiments will be modeled. The chemistry code development and evaluation should be completed in that same period of time. The debugging of the 2-D thermomechanical code will continue with the calculation of sample problems.

2282 (FE—1794-13) **Development of a continuous Dry Coal Screw Feeder. Quarterly technical progress report, April 1, 1976—June 30, 1976.** Mistry, D.K. (Ingersoll-Rand Research, Inc., Princeton, N.J. (USA)). Jul 1976. Contract E(49-18)-1794. 35p. Dep. NTIS $4.00.

During this quarter, coal testing was initiated with Negri-Bossi No. V-12 machine. The following conclusions were drawn from the testing to date. Various types and sizes of coal can be pumped against a back pressure of 1,500 psig using a thermoset-type screw and taking advantage of the plasticizing properties of the coal. Coal properties with respect to temperature, pressure, and time are extremely important for the extrusion process and the extrudate quality. Systematic process parameters study is essential for the successful development of Dry Coal Screw Feeder. Special attention will be required in designing coal feeding and extrudate discharge areas.

2283 (FE—2000-3) **Membrane applications to coal conversion processes. Quarterly report, December 5, 1975—March 4, 1976.** Schell, W.J.; Lawrence, R.W. (Envirogenics Co., El Monte, Calif. (USA)). May 1976. Contract E(49-18)-2000. 54p. Dep. NTIS $4.50.

A cost study for membrane gas separation as applied to coal gasification processes was conducted based on current permeation characteristics for cellulose acetate blend membrane in a spiral module configuration. It was found that the hydrogen production cost estimates ranged from $0.35 to $1.21/MSCF H_2 compared to from $0.58 to $1.02/MSCF H_2 estimated from current technology production. The wide range in these costs was due in part to the estimate of the feed gas value. A major portion of the technical effort involved a continuation of the characterization of cellulose acetate blend membranes. Measurements were made of permeation rates and separation factors as functions of time, gas moisture content, plasticizer content and, in the case of a H_2/CO gas mixture, the experimental separation factor. In addition, various types of cloths were studied for the production of cast-on-cloth blend membranes. Several 2-in. dia. spiral modules were fabricated and tested up to 750 psig. Some performed satisfactorily and failure modes were determined for the others. Polysulfone membrane development continued with little improvement in either permeation rates or separation factors. An initial result with a composite-type membrane indicated potential as an alternate to asymmetric membrane fabrication.

2284 (FE—2030-3) **Characteristics of American coals in relation to their conversion into clean energy fuels. Quarterly technical progress report, January—March 1976.** Spackman, W.; Davis, A.; Walker, P.L.; Lovell, H.L.; Essenhigh, R.H.; Vastola, F.J.; Given, P.H. (Pennsylvania State Univ., University Park (USA)). May 1976. Contract E(49-18)-2030. 193p. Dep. NTIS $7.50.

Responses to the questionnaire, which was distributed to determine the extent to which the nation's coal seams have been sampled and characterized, are being received. Early comparisons indicate a mathematical relationship between average random reflectance (Rapid Scan) and the mean-maximum reflectance as obtained by standard reflectance analysis. Results obtained so far show support of a diffusion dominance mechanism in the oxidation region of a combustion pot and a chemical kinetic mechanism in the gasification region. Values of reaction rates in coke beds have been calculated from experiments with a fixed bed shaft gasifier. Devolatilization of a North Dakota lignite in a laminar flow reactor and subsequent treatment of the resulting char has shown that weight loss is strongly dependent upon the isothermal decomposition time. Although gasification rates increase with increase in partial pressure of oxygen, the mechanism for gasification of a given char is independent of partial pressure of oxygen. Study of the reactivity of ion-exchanged lignite chars to steam shows that increased heat treatment decreases reactivity and ion exchange increases reactivity. Use of the DSC technique to study the thermal effects involved during chemisorption of oxygen on Saran carbon has yielded information on the activation energy (EA) of the reaction. Work on the infinite parallel plane char combustion computer model has determined that low volatile chars and coals can be suitable fuels if adequate available internal surface area is present.

2285 (FE—2203-8) **Investigation of converting the product of coal gasification to methane by the action of microorganisms. Phase I. Second quarterly report, February 1, 1976—May 1, 1976. Dynatech report No. 1411.** Wise, D.L. (Dynatech R/D Co., Cambridge, Mass. (USA)). 15 Jun 1976. Contract E(49-18)-2203. 112p. Dep. NTIS $5.50.

Methanation experiments have continued with continuous and batch cultures of microorganisms on test gas mixes of both CO_2/H_2/trace H_2S and $CO/CO_2/H_2$ trace H_2S. It has now been established that the methanation process on CO_2/H_2/trace H_2S is highly reliable. Two reactors were each operated on this test gas feed and produced methane continuously for over 50 days. Analyses under the experimental conditions chosen indicate that approximately 97 percent of the feed gas carbon consumed is converted to methane. About 1-2 percent of the input carbon is incorporated into biomass, and another 1 percent is incorporated into volatile organic acids, principally acetic. These components leave as side product streams in the aqueous phase. Initial experiments indicate that the fermentation proceeds well at elevated pressure. In a current experiment, production is being maintained at 16 volumes/volume/day at a pressure of 100 psig. Nutrient requirements of organisms are being defined. Specifically, it has been determined that use of calcium carbonate (as a buffer) with trace salts and yeast extract in the feed (as a source of vitamins) has resulted in a quadrupling of methane output since the initiation of experiments.

2286 (FE—2231-1) **Heat transfer in a fluidized countercurrent bed. Interim report, May—July 1976.** Jackson, R. (Rice Univ., Houston, Tex. (USA)). Aug 1976. Contract E(49-18)-2231. 18p. Dep. NTIS $3.50.

During the current quarter preliminary experiments were performed that provide information needed in the design of the main experimental apparatus. This information is of two sorts. First, a selection of particles have been characterized for use in the fluidized bed and as descending heat transfer particles. They have been chosen so that the effect of variations in size and density about the values of greatest current practical interest can be investigated. Second, measurements have been made of the limiting downflow rates of larger and heavier particles through fluidized beds of smaller and lighter particles, for a number of selected particle pairs. These provide the information needed to determine the maximum practicable size for the experimental apparatus, and to design the fluidized bed and particle feed hoppers. On the basis of the information obtained in these preliminary experiments, the test rig for the main body of the experimental work has been designed.

2287 (LERC/RI—76/2) **In situ coal gasification model (forward mode) for feasibility studies and design.** Gunn, R.D.; Whitman, D.L. (Bureau of Mines, Laramie, Wyo. (USA). Laramie Energy Research Center). Feb 1976. 43p. Dep. NTIS $4.00.

A linear mathematical model for forward combustion has been developed for underground gasification of coal. Predicted results agree very well with data obtained from a field test conducted by the Laramie Energy Research Center near Hanna, Wyoming. With the aid of the model, field tests can be interpreted quantitatively in terms of known chemical and physical phenomena. This leads to a greater understanding of the process, and establishes a method for determining optimum operating conditions such as air injection rate, air/water ratio, and preheating of injection air. (auth)

2288 (UCRL—50026-76-2) **LLL in situ coal gasification program. Quarterly progress report, April—June 1976.** Stephens, D.R.; Shearer, W.O. (eds.). (California Univ., Livermore (USA). Lawrence Livermore Lab.). 12 Jul 1976. Contract W-7405-ENG-48. 27p. Dep. NTIS $4.00.

Planning for Phase 2 of Hoe Creek Experiment No. 1 continued. Although the instrument holes slough at the bottom of the Felix No. 2 coal seam, it has been possible to emplace instrumentation and complete the holes. Four of the six instrument holes have been completed. Five holes have been cored. Core recovery in the fractured Felix No. 2 coal, using the wireline technique, was excellent—greater than 80 percent. All cores show that the bottom 5 to 10 ft of the coal is highly fractured. The surface plant for the Hoe Creek gasification experiment is described, and schematics given for its piping and instrumentation, surface-water piping, surface gas-pipe assembly, and flare. The plant has been designed for maximum flexibility. Several coal-program reports were published and abstracts given describe: Extensive mechanical properties measurements for Kemmerer subbituminous coal; pyrolysis of Wyodak subbituminous coal; gasification of Wyodak and Felix chars; and

preliminary laboratory and modeling studies on the environmental impact of in-situ coal gasification. Plans are presented for a book reviewing the Russian underground coal gasification effort. Two-dimensional dewatering calculations were performed for Hoe Creek. Electrical conductivity studies on coal and char sharpened the transition from insulating coal to conducting char. Char conductivity increases nine orders of magnitude when heated from 600 to 700°C.

2289 (UCRL—52035(Pt.2)) **Pyrolysis of subbituminous coal as it relates to in situ gasification. Part 2. Characterization of liquid and solid products.** Campbell, J.H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 Jun 1976. Contract W-7405-Eng-48. 23p. Dep. NTIS $3.50.

The pyrolysis of subbituminous Roland seam coal (Wyodak Mine) was investigated in an inert gas environment at 110 to 1000°C and 0.1 MPa. This second of a two-part study examines the liquid and solid products. Its results reveal the temperature region of major tar release and characterize the evolved organic tar by elemental composition, boiling point range, and chromatographic fingerprint. The evolution of low-molecular-weight hydrocarbons and sulfur compounds is discussed in terms of the coal's composition. The effect of temperature on the structure of char is examined by analysis of the change in elemental composition, surface area, and electric conductivity vs temperature of char formation. The char's elemental composition shows typical enrichment in carbon and depletion in hydrogen as a result of pyrolysis. Its surface area increases 50-fold while conductivity increases by 10 orders of magnitude between 300 and 800°C. An investigation of the effects of hydrogen and carbon monoxide environments on coal weight loss during pyrolysis shows that hydrogen (at about 1 bar) enhances weight loss whereas carbon monoxide has a retarding effect. Combined results from Parts 1 and 2 produce a simple mechanistic picture of subbituminous coal pyrolysis.

2290 (UCRL—77627(Rev.1)) **Numerical model of coal gasification in a packed bed.** Winslow, A.M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jul 1976. Contract W-7405-eng-48. 30p. (CONF-760801—4). Dep. NTIS $4.00.

From 16. international symposium on combustion; Cambridge, Massachusetts, United States of America (USA) (15 Aug 1976).

A one-dimensional time-dependent computational model has been developed as a pilot study for the multidimensional simulation of coal gasification in a packed bed, treated as a porous medium. Different gas and solid temperatures are used, and concentrations of eight chemical species (N_2, O_2, H_2O, H_2, CH_4, CO, CO_2, tar), two forms of water (surface and interior), coal, and char are followed in space and time. Numerical results obtained for gasification of a Wyoming subbituminous coal by a mixture of steam and oxygen show reasonable agreement with laboratory measurements. The numerical method retains all time derivatives and treats the nonlinear partial differential equations as an initial-value problem, using implicit methods that are capable of being extended to two or more space dimensions.

2291 (UCRL—78302) **Lawrence Livermore Laboratory in-situ coal gasification program: model calculations and laboratory experiments.** Thorsness, C.B.; Rosza, R.B. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 8 Jul 1976. Contract W-7405-eng-48. 24p. (CONF-761008—2). Dep. NTIS $3.50.

From 51. annual meeting of the Society of Petroleum Engineers; New Orleans, Louisiana, United States of America (USA) (3 Oct 1976).

The Lawrence Livermore Laboratory concept for in-situ coal gasification involves fracturing thick, deep, coal seams using chemical explosives. The resultant high-permeability zone would then be ignited and reacted with a steam/oxygen mixture to produce medium-Btu gas suitable for upgrading to pipeline quality in a surface plant. Calculational modeling and supporting laboratory experiments relating to the gasification process are described. The primary aim of this preliminary work is to predict and correlate reaction and thermal-front propagation rates and product gas composition as a function of bed properties and process operating conditions. Initial efforts are restricted to one-dimensional, transient Darcy flow in a permeable packed bed. The numerical calculations include a detailed description of the chemistry of the reacting system (13 species), with appropriate reaction rates and overall heat and mass transport in the system. Comparison of the calculated results with experimental data from a packed-bed combustion tube shows good agreement for reaction-zone propagation rates and produced-gas compositions. However, the sensitivity of the calculations to other reaction-rate and transport-coefficient models should be investigated.

2292 (UCRL—78304) **Lawrence Livermore Laboratory coal gasification program: underground reaction modeling and laboratory combustion-tube experiments.** Rozsa, R.; Thorsness, C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 21 Jul 1976. Contract W-7405-Eng-48. (CONF-760817—3). Dep. NTIS $3.50.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

The in-situ coal-gasification concept currently under study at the Lawrence Livermore Laboratory calls for the fracturing of thick, deep, coal seams by means of chemical explosives. The high-permeability zone created by the blast would be ignited and reacted with a steam/oxygen mixture to produce medium-Btu gas. This gas could then be upgraded to pipeline quality in conventional surface facilities. Recent calculational modeling and combustion-tube experiments carried out to evaluate the workability of the general coal-gasification concept are discussed. The chief purpose is to predict and correlate reaction and thermal-front propagation rates and product-gas composition as a function of bed properties and process operating conditions. The preliminary model considers only one-dimensional transient Darcy flow in a permeable packed bed. The normal conservation equations are coupled by chemical reactions and heat and mass transfer. The combustion tube, 1.6-m long and 0.15-m in diameter, is designed for conditions up to 6.9 MPa (1000 psi) and 1300°K. It is equipped with electric heaters to reduce radial heat losses. Results of a simulation of combustion-tube-reactor test runs are compared with observations. Good agreement is shown between calculated and experimentally observed reaction-front propagation rates as well as produced-gas compositions.

2293 (UCRL-Trans—11101) **Underground gasification in various countries. INICHAR report (continuation). II. Experiments in Italy. III. Experiments at Gorgas (U.S.).** Translated from *Ann. Mines Belg.;* **50**: No. 2, 174-195(Mar 1951). 60p. Dep. NTIS $4.50.

Experimental results on underground gasification experiments in Italy and USA are given in considerable detail. Experiments in both countries involved underground gallery preparation of seams not too far below the surface, so leaks from the fire zone were a problem. The gas produced was of low and erratic quality (some of the problems were caused by interruptions of electric current to the blowers, special experiments, etc.). Some of the US experiments involved oxygen and/or steam (for several hours each) and there resulted in gas of higher calorific value. Samples of gas taken from underground by special sampling lines were often of higher calorific value than gas which was brought to the surface by the main channel (bypassing of fire zone by air or oxygen). The efficiency was not very high, partly due to high heat losses to the ground. Information discovered by underground examination of the cooled fire zone is recorded. Gas composition and efficiency calculations made at various times during the tests are given. (LTN)

2294 (UCRL-Trans—11107) **Underground gasification in various countries. INICHAR report. V. Tests at Bois-La-Dame (Lige) (continued).** Translated from *Ann. Mines Belg.;* **51**: No. 2, 149-172(Mar 1952). 80p. Dep. NTIS $5.00.

The progress of the test was greatly disturbed by several events: a very large roof-fall a few hours after the beginning of the test, caused an almost complete obstruction of the passage opened to the gas stream; destruction of the burner placed at the head of the face, after each of the first two ignitions, making it impossible to use it later to revive the fire at the head of the face; development of communication with the site of the first test (producing significant air returns), lack of tightness of the dams, cracking of the ground, and finally, by the obstruction of the face; and development of a fire in the head level after each of the first two ignitions, and also in the base level one month after the first ignition. At a high air flow rate the entire seam is consumed, leaving behind it only a mass of ash, scoria and debris from the walls. This material is porous, furrowed with cracks and crevices, and permeable to air and water, so it can cause a diversion of the gas stream behind the fire zone. Attempts made to block the channel packing were only very partially successful. A gas having a calorific value not much higher than 400 calories was obtained by blowing air only for a few days toward the beginning of the first active period when the flow rate was very low. The quality of the gas drops as the test is prolonged, due to the diversion of a fraction of the gas stream behind the fire zone through the packing and due to the reduction of the ratio of distilled coal to gasified coal. Short runs with oxygenated air and oxygen steam mixtures produced gas of high calorific value, but are difficult to interpret in detail or to compare with each other. (LTN)

2295 (UCRL-Trans—11131) **Methods of analyzing groundwater polluted during underground gasification of coal for the content of phenol-type organic substances.** Yanshina, M.S. Translated

from *Podzemn. Gazif. Uglei;* No. 2, 72-73(1958). 6p. Dep. NTIS $3.50.

Two methods are given for determining phenols in groundwater polluted by underground gasification. (LTN)

2296 (UCRL-Trans—11113) **Influence of certain properties of brown coal on the process of the shifting of the fire face against the blast flow.** Zybalova, G.P.; Zvyagintsev, K.N. *Podzemn. Gazif. Uglei;* No. 2, 46-51(1959). 17p. Dep. NTIS $3.50.

In filtration crosscutting, the crosscut channels are formed by shifting the fire face through the coal, directing at the face the blast from a shaft which has been cut. The rate of movement of the fire face is a function of both the composition and the physical and chemical properties of the hot mass and the ash content of the coal. We can trace the dependence of the temperature of the process and the movement of the fire face upon the flow rate of the blast applied to the process. The temperature varied from 700 to 1160° in experiments with an air blast. The length of the incandescent zone during movement of the fire face in an air blast depends on the flow rate of the blast supplied to the process and on the ash content of the coal. With an air blast at low blast flow levels movement of the fire face takes place primarily due to combustion of the volatiles in the coal. As the blast flow rate increased, there was increased involvement of the nonvolatile portions of the hot mass of coal. Increasing the oxygen concentration in the blast from 21 percent to 98 percent increases the rate of movement of the fire face 5-6 fold. The movement of the fire face in an oxygen blast takes place primarily due to combustion of the volatiles in the coal. The length of the incandescent zone is much less than when the process takes place in an air blast.

2297 (UCRL-Trans—11124) **Underground gasification of coal.** Koranda, J.; Koutink, J.; Peer, V. Translated from *Pr. Ustavu Vyzk. Paliv;* No. 5, 5-33(1962). 53p. Dep. NTIS $4.50.

It has been unprofitable to mine the large lignite reserves in Czechoslovakia. Also, in areas where coal has been mined, a considerable fraction has been left underground. Underground gasification may make it possible to use these reserves. The Russian work on underground gasification is reviewed and the various methods discussed briefly: underground galleries or linked vertical shafts, drying or not drying before gasification, hole linking methods (hydraulic fracturing, electrolinking, filtration, etc.), spacing in and between rows of holes. Experimental work between 1956 and 1960 confirmed the feasibility of, and validated certain techniques for, underground gasification. It was, however, found to be unfeasible to gasify thin seams (less than 0.5 m) and the gas produced from seams 0.5 to 1 m thick had a low calorific value (600 kcal/N m^3). The significant part of the report is an engineering economy study of underground gasification based partly on Soviet experience: percent of coal gasified (losses 0 to 30 percent), maximum hourly yield per shaft (3000 to 4000 N m^3), blast pressure (6 psig or greater for linking, 0.5 to 2 psig for gasification, pressure changes with time, optimum shaft pipe and casing size, limits on ash, water, calorific value of coal, minimum seam thickness and depth, permeability, optimum spacing between shafts and rows, etc. Finally, capital costs of power plants based on underground gasification and a surface mine and coal-fired boiler are estimated, with some attempt to allow for the size of the plant. As a result, it was decided to construct a pilot plant to obtain more basic engineering-economic data for planning and building a plant on an industrial scale. The pilot plant will have a capacity of 20,000 Nm^3 of gas per hour and will be combined with a package boiler unit with an output of 1.5 MW. Additional gas will be burned in an experimental combustion chamber to determine the suitability of different types of burners.

2298 (UCRL-Trans—11139) **Combined method of linking boreholes at the Shatskii Podzemgaz Station.** Krein, G.F.; Miringof, N.S. Translated from *Tr. Inst. Proizvod. Opyt, Vses. Nauchno-Issled. Inst. Ispol'z. Gaza Nar. Khoz. Podzemn. Khraneniya Nefti, Nefteprod. Szhizhennykh Gazov;* No. 1, 125-132(1965). 17p. Dep. NTIS $3.50.

Developments in linking boreholes (about 30 m apart) for underground gasification are reported. The coal seam was first fractured hydraulically using an 8 to 10 percent sodium chloride solution, with pumps which had an operating pressure of 30 atmospheres and a pumping rate of 2.3 to 3 m^3/min. After fracturing, the remaining solution was forced from the borehole with air at relatively low pressure. Electrolinking was then accomplished with 1100 kVA equipment, using voltages of 600 to 1100 V and currents of 160 to 200 A. The use of the saline solution lowered the resistance (by a factor of about 2) and electrolinking was accomplished in a shorter time. The electrodes were insulated from the borehole casing and ended in a steel cap (at seam depth). Contact with the seam was improved with a mixture of fine graphite and coal tar. It is proposed that without the saline solution (and therefore higher resistance) the current spreads out and considerable energy is lost by leakage or used ineffectively; with the solution the current is much more concentrated and more effective in coking the channel walls. Finally, the channels were cleared with air. The experiments were successful in the effectiveness of linking and in insuring the formation of directed, extended channels for subsequent gasification. (LTN)

2299 (UCRL-Trans—11137) **Effect of operating conditions on the formation of methane during pressure gasification.** Riedl, R.J.; Vodsedalek, J. Translated from *Plyn;* **48**: No. 7, 226-229(1968). 16p. Dep. NTIS $3.50.

The dependence of the methane content of crude gas, produced by pressure gasification, on the gasification ratio was studied. On the basis of an analysis of the results of operations at the Uzin Pressure Gasworks between 1 January 1965 and 30 June 1967, a relationship was discovered between the partial pressure of hydrogen in the generator and the methane content of the gas. Lowering the gasification ratio increases the partial pressure of hydrogen in the generator due to a higher degree of steam dissociation, which has a favorable effect on methane formation. This relationship was found to apply in the gasification range from 4.7 to 7.1 kg steam/Nm^3 oxygen.

2300 170th national meeting of the American Chemical Society, Division of Fuel Chemistry, Chicago, Illinois, August 24—29, 1975. Volume 20, No. 3. Schora, F.C. Jr.; Mills, G.A. Chicago; American Chemical Society (1975). 225p. (CONF-750806—P1). $7.00.

From 170. American Chemical Society national meeting; Chicago, Illinois, USA (24 Aug 1975).

An abstract was prepared for each of 18 papers in this volume. (EJH)

2301 Devolatilization of coal and zinc chloride: impregnated coal in a nitric oxide atmosphere. Bodlily, D.M.; Lee, S.H.D.; Wiser, W.H. (Univ. of Utah, Salt Lake City). *Am. Chem. Soc., Div. Fuel Chem., Prepr.;* **20**: No. 3, 7-11(1975).

From 170. American Chemical Society national meeting; Chicago, Illinois, USA (24 Aug 1975).

See CONF-750806—P1.

Zinc chloride is known to be an effective coal hydrogenation catalyst when impregnated in small amounts on the coal surface or when mixed with coal in amounts in excess of the coal. The mechanism of interaction of zinc chloride is not understood. Previously reported studies have shown that zinc chloride and other metal halides suppress the evolution of tar and gases during pyrolysis of coal in nitrogen atmospheres. This was shown to be due to the dehydrogenation of hydroaromatic structures in the coal at temperatures below the onset of pyrolysis reactions. This reaction is accompanied by other structural changes in the coal. These experiments have been extended to nitric oxide-nitrogen atmospheres. Nitric oxide is a free-radical scavenger and is known to alter the pyrolysis behavior of coal. Thermogravimetric analysis of coal in a flow system of nitrogen and nitric oxide (NO/sub N2/ = 0.1) shows a decrease in the devolatilization of the coal in the temperature range 200-650°C as compared to coal heated in a nitrogen atmosphere. Above 650°C there is pronounced oxidation in the presence of nitric oxide. Coal samples impregnated with zinc chloride show a greater suppression of volatility over this temperature range. Similar results are observed in isothermal experiments. The total suppression of volatility for the zinc chloride-impregnated sample in nitric oxide is approximately the sum of the separate effects of zinc chloride and of nitric oxide. This indicates that the interaction of zinc chloride with coal does not involve free-radicals.

2302 Development of a fluidized bench-scale reactor for kinetic studies. Friedman, L.D. (COGAS Development Co., Princeton, NJ). *Am. Chem. Soc., Div. Fuel Chem., Prepr.;* **20**: No. 3, 34-44(1975).

From 170. American Chemical Society national meeting; Chicago, Illinois, USA (24 Aug 1975).

See CONF-750806—P1.

The TGA apparatus is widely used to obtain kinetic data on the devolatilization of coal and the reactivities of chars with gases. However, TGA results often correlate poorly with results obtained in large-scale pilot plant fluidized reactors. In addition, the TGA apparatus uses such small samples that insufficient solids, gases, or liquids are produced to permit characterization of the reaction products. A versatile, small, fluidized-bed bench-scale Coal Evaluation Unit (CEU) which has been used to study the pyrolysis of coals and the reactivities of chars with gases is described. Results obtained in the CEU correlate well with results obtained in fluidized-bed pilot plants. High-volatile bituminous coals which agglomerate in conventional fluidized-bed reactors can be devolatilized in the CEU. With this unit, one operator can determine both the pyrolytic behavior of a coal and the gasification characteristics of the resulting char in one day.

2303 Factors effecting reactivity of coal chars. Walker, P.L. Jr.; Hippo, E.J. (Pennsylvania State Univ., University Park). *Am. Chem. Soc., Div. Fuel Chem., Prepr.*; **20**: No. 3, 45-51(1975).

From 170. American Chemical Society national meeting; Chicago, Illinois, USA (24 Aug 1975).

See CONF-750806—P1.

It is helpful when attempting to understand the reactivity of coal chars to draw on what is known about gas-solid interaction from voluminous studies on both the gasification of more crystalline carbons and heterogeneous catalysis. Rates of gasification of porous carbons are primarily affected by three parameters: active site concentration, accessibility of the reactant gas into the total internal surface area, and presence of catalysts which are active for the dissociation of molecular species into reactive oxygen atoms or hydrogen atoms. Following a discussion of these parameters, reactivities of 16 chars produced from coals of varying rank are considered. Reactivities of chars increase rapidly with decreasing rank of the precursor coals, showing over a 100-fold difference. Char reactivities can be changed significantly by variations in coal particle size, coal pretreatment, and heat treatment temperature. These reactivities are considered in light of basic principles.

2304 Catalyzed gasification of coals and coal chars. Wilks, K.A.; Gardner, N.C.; Angus, J.C. (Case Western Reserve Univ., Cleveland). *Am. Chem. Soc., Div. Fuel Chem., Prepr.*; **20**: No. 3, 52-60(1975).

From 170. American Chemical Society national meeting; Chicago, Illinois, USA (24 Aug 1975).

See CONF-750806—P1.

Gasification of high volatile bituminous coals and coal chars with hydrogen and steam was studied at 500 and 1000 psig and 650 to 850°C in a thermobalance. The following classes of catalysts were used singly and in combination: acidic cracking catalysts, methanation catalysts, hydrogenation catalysts and potassium salts. Simple mathematical modelling indicates that for catalyzed and noncatalyzed systems the geometric similarity of the coal particles change as they are gasified, and hence the mass transfer rates change also. The catalysts had relatively little influence on the initial devolatilization, but had a strong influence on the preexponential factor and activation energy of the gasification of the residual char. Annealing of the coal samples in the presence of the catalyst before reaction increased the ultimate reaction rate. It is not known whether this is caused by diffusion of the catalyst into the mass, or whether the specific surface area of the sample was affected. Potassium salts, acting by themselves, were the most effective. In all cases, at least 5 wt. percent of catalyst was required, indicating that physical as well as purely chemical catalytic processes may be operative.

2305 Gasification of Montana lignite in hydrogen and in helium during initial reaction stages. Johnson, J.L. (Inst. of Gas Tech., Chicago). *Am. Chem. Soc., Div. Fuel Chem., Prepr.*; **20**: No. 3, 61-87(1975).

From 170. American Chemical Society national meeting; Chicago, Illinois, USA (24 Aug 1975).

See CONF-750806—P1.

The initial stages of gasification of 80-micron particles of Montana lignite in hydrogen and in helium were studied in a novel dilute—phase transport reactor at pressures from 18 to 52 atm., and at temperatures from 900 to 1550°F. The reactor, consisting of a 200-ft-long, 1/16-in.-ID helical coil, was heated by direct electrical input to the coil, with independent temperature control in nine equally spaced zones to permit variation in time-temperature profiles of gas-solids mixtures passing cocurrently through the coil. Kinetic data were obtained that define the gasification of individual organic coal components and the formation of major gaseous species, as a function of gas composition, time-temperature history, and pressure. Particular attention was directed toward development of a mathematical model to describe the kinetics of methane and ethane formation as a function of hydrogen partial pressure and time-temperature history, consistent with results obtained for operation of the experimental reactor under isothermal conditions (gas-solids residence times from 5 to 15 sec), and for operation under conditions of constant gas-solids heat-up rate (50°F/sec).

2306 Rate of reaction of oxygen and steam with char/coke. Nandi, S.P.; Lo, R.; Fischer, J. (Argonne National Lab., IL). *Am. Chem. Soc., Div. Fuel Chem., Prepr.*; **20**: No. 3, 88-98(1975).

From 170. American Chemical Society national meeting; Chicago, Illinois, USA (24 Aug 1975).

See CONF-750806—P1.

Three subbituminous coals and one MVB coal were pyrolyzed in a nitrogen atmosphere to 900°C. The pyrolyzed residues were reacted with oxygen and steam. The rate of reaction was followed gravimetrically using a thermobalance. The particle size of the sample was (40 x 80) mesh and the bed height was about one particle diameter. Reaction with air was followed at four temperatures in the range 400 to 600°C. After an induction period the weight loss was linear with time for an extended burn-off range. The rate of reaction was obtained from the linear region and was found to increase with a decrease in the rank of the parent coal. The temperature coefficient of the rate was low. The slope of the Arrhenius plots decreased with increasing temperature and attained a value of approximately 15 Kcal/mole for chars in the temperature interval between 500 to 550°C. A similar decrease in the slope of the plot for the coke was observed at approximately 50°C higher temperature. Reaction with 2.3 vol percent of steam was followed with the same samples in the temperature range 800 to 900°C. Induction periods for the reaction with steam were very short or nonexistent. The reaction rate was zero order with respect to carbon for an extended burn-off region. The temperature coefficient of the rate (approximately 30 Kcal/mole for the chars) tends to indicate that the rate was pore-diffusion-controlled and suggests that a possible catalytic effect due to the mineral content of the chars may have been operative.

2307 Reactivity of coal and char in CO_2 atmosphere. Dutta, S.; Wen, C.Y.; Belt, R.J. (West Virginia Univ., Morgantown). *Am. Chem. Soc., Div. Fuel Chem., Prepr.*; **20**: No. 3, 103-114(1975).

From 170. American Chemical Society national meeting; Chicago, Illinois, USA (24 Aug 1975).

See CONF-750806—P1.

Reactivities of a few raw coals and chars of these coals obtained from gasifiers operating under different conditions have been measured in CO_2 at the temperatures 1550 to 2000°F. The reactivities have been measured in a thermogravimetric analyzer up to complete conversions of the samples in most cases. Properties like surface area, pore size distribution, porosity, and density have been determined for each sample. Actual pore structures of a few samples have been observed at different conversion levels by a scanning electron microscope. In order to compare the reactivities of different samples, the char-gasification process has been divided into two distinct stages: the first stage due to pyrolysis and the second stage due to char-CO_2 reaction. Reactivities due to the first stage can be roughly related to volatile matter contents of the solids and the rate of heating. Through an Arrhenius type equation, an activation energy of about 2.5 Kcal/mole is obtained for the first stage. The reactivity of a char in the second stage is found to depend more on its coal seam than on the gasification scheme used in its production. Activation energy for the second stage reaction has been found to be about 59 Kcal/mole.

2308 Gasification of HYDRANE char in reactions with carbon dioxide and steam. Fuchs, W.; Yavorsky, P.M. (Pittsburgh Energy Research Center). *Am. Chem. Soc., Div. Fuel Chem., Prepr.*; **20**: No. 3, 115-133(1975).

From 170. American Chemical Society national meeting; Chicago, Illinois, USA (24 Aug 1975).

See CONF-750806—P1.

Hydrogasification of coal requires coal and hydrogen as raw materials. It has been proposed that the residual char of the process could be used to produce the needed hydrogen. In the HYDRANE process, the residual char still contains 50 percent of the carbon which was present in the original coal. Tests have been made on the HYDRANE char to obtain kinetic information concerning the water gas reactions. It has been proposed that the limiting step in this gasification reaction is the rate of carbon transfer from the solid state to the gaseous state in the form of carbon monoxide. In this case, steam-char reactions should yield the same gasification rate constant as carbon dioxide-char reactions. This has been confirmed within the accuracy of the experimental procedures. At pressures between 18 and 34 atm. and at temperatures between 700 and 900°C, the rate constant for carbon gasification can be represented by an Arrhenius expression $R = A \exp(-E/RT)$ with an activation energy of $E = (56 \pm 3)$ kcal/mol, and with a frequency factor of A approximately equal to $2 \times 10^7 s^{-1}$. The activation energy is in good agreement with the results of previous work done on different char and coal materials. The frequency factor compares with values from published literature within an order of magnitude. A dependence of the reaction rate on the partial pressure of the reactant has not been observed if the reaction products were removed rapidly; this agrees with previous work. Results from an experimental gasification unit using the water gas reaction (SYNTHANE) have been found to agree reasonably well with these data.

2309 Coproduction of methanol and SNG from coal: a route to clean products from coal using "ready now" technology. McGhee, R.M. (Transco Energy Co., Houston, TX). *Am. Chem. Soc., Div. Fuel Chem., Prepr.*; **20**: No. 3, 147-170(1975).

From 170. American Chemical Society national meeting; Chicago, Illinois, USA (24 Aug 1975).

See CONF-750806—P1.

A brief evaluation is presented of technologies that are ready now, with brief comments on their thermal efficiency and capital cost. New processes and new technology not yet proven on a commercial scale are outside the scope of this paper. A discussion is presented on what are believed to be the best opportunities for full-scale commercial plants that could be on stream as early as five years from the date of approval to proceed. A proposed plant which would produce both SNG and methanol from coal is defined. This includes the processing configuration, the capital and operating costs, and the required sales price to assure a profitable venture.

2310 Coal gasification at the Belle Works. McGeorge, A.; Green, R.V. (E. I. du Pont de Nemours and Co., Inc., Wilmington, DE). *Am. Chem. Soc., Div. Fuel Chem., Prepr.*; **20**: No. 3, 182-190(1975).

From 170. American Chemical Society national meeting; Chicago, Illinois, USA (24 Aug 1975).

See CONF-750806—P1.

The commercial scale coal gasification unit was started up and operated at the Belle Works of the Polychemicals Department of Du Pont in 1955-56. Known as the Du Pont, Babcock And Wilcox Gasifier, it was a slagging, entrained powdered coal unit designed to produce 24MM early 1950CFD of synthesis gas used at Belle to make methanol, ammonia, and other products. During the fifteen months of operation, the gasifier ran at greater than or equal to 90 percent utility for several extended campaigns, but several major shutdowns occurred which were related to the erosion of the refractory lining in the slag pool and to fly ash and slag occlusion of waste heat boiler tubes. The Du Pont gasifier was developed from a pilot plant operated at Belle Works in the early 1950s, and was converted to natural gas in 1957.

2311 170th national meeting of the American Chemical Society, Division of Fuel Chemistry, Chicago, Illinois, August 24—29, 1975. Volume 20, No. 4. Schora, F.C. Jr.; Mills, G.A. Chicago; American Chemical Society (1975). 284p. (CONF-750806—P2). $7.00.

From 170. American Chemical Society national meeting; Chicago, Illinois, USA (24 Aug 1975).

An abstract was prepared for each of 14 papers in this volume. (EJH)

2312 Relationship between the gasification reactivities of coal char and the physical and chemical properties of coal and coal char. Johnson, J.L. (Inst. of Gas Tech., Chicago). *Am. Chem. Soc., Div. Fuel Chem., Prepr.*; **20**: No. 4, 85-102(1975).

From 170. American Chemical Society national meeting; Chicago, Illinois, USA (24 Aug 1975).

See CONF-750806—P2.

Possible relationships between coal-char gasification reactivities, and physical and chemical coal and coal-char properties were explored. Gasification tests were conducted with hydrogen and steam-hydrogen mixtures in a thermobalance apparatus under constant environmental conditions at elevated pressures and temperatures to obtain the information necessary to define relative reactivity factors of the different coal chars evaluated. Potentially useful correlations relating gasification reactivity factors of coal chars to relatively simple compositional parameters of raw coals of a wide range of rank and maceral composition are discussed. Results are also presented to characterize variations in internal surface areas and pore volume distributions of several selected coal chars during the course of gasification.

2313 Hydrogasification kinetics of bituminous coal and coal char. Gray, J.A.; Donatelli, P.J.; Yavorsky, P.M. (Pittsburgh Energy Research Center). *Am. Chem. Soc., Div. Fuel Chem., Prepr.*; **20**: No. 4, 103-154(1975).

From 170. American Chemical Society national meeting; Chicago, Illinois, USA (24 Aug 1975).

See CONF-750806—P2.

A simple kinetic model based on carbon conversion in three consecutive stages was used to examine the kinetics of hydrogasification in four different types of reactors with hydrogen partial pressure and temperature ranging from 15 to 205 atm and 425 to 1200°C, respectively. Depending on the type of reactor and temperature range, the activation energies varied from 4.4 to 53.9 kcal/mole of carbon hydrogasified. Severe mass transfer resistance was evident under some conditions. Correlations based on carbon conversion have been developed for calculating the char yield and the dispositions of coal hydrogen, nitrogen, sulfur, and oxygen, independent of reactor conditions and geometry.

2314 Hydrogasification of HYDRANE char in fluidized and moving beds. Wen, C.Y.; Mori, S.; Gray, J.A.; Yavorsky, P.M. (West Virginia Univ., Morgantown). *Am. Chem. Soc., Div. Fuel Chem., Prepr.*; **20**: No. 4, 155-206(1975).

From 170. American Chemical Society national meeting; Chicago, Illinois, USA (24 Aug 1975).

See CONF-750806—P2.

To satisfy future pipeline gas requirements, considerable process development work is being aimed at gasifying coal to produce substitute natural gas (SNG). The heart of many of the gasification processes being developed is a fluid-bed gasifier in which char is reacted with steam/oxygen or hydrogen. In the HYDRANE process, being developed at the U.S. Bureau of Mines, Pittsburgh Energy Research Center, char is reacted directly with hydrogen in the fluid-bed stage of the hydrogasifier. In order to scale-up the fluid-bed reactor to pilot plant or commercial size with confidence, a fluid-bed reactor model has been developed using the bubble-assemblage concept and has been shown to fit existing data reasonably well. Data from moving-bed reactor experiments and the corresponding model were compared to the fluid-bed results and illustrate the differences between plug-flow and well-mixed solid-gas reactors.

2315 (HYDRO) gasification of Battelle treated coal (BTC). Chauhan, S.P.; Feldman, H.F.; Stambaugh, E.P.; Oxley, J.H. (Battelle Columbus Labs., OH). *Am. Chem. Soc., Div. Fuel Chem., Prepr.*; **20**: No. 4, 207-218(1975).

From 170. American Chemical Society national meeting; Chicago, Illinois, USA (24 Aug 1975).

See CONF-750806—P2.

Experimental results are presented demonstrating the advantages of a novel treatment process that, in addition to enhancing the reactivity of coal to steam and hydrogen, eliminates the swelling and caking properties of even the most highly caking eastern coals. The results were generated in a pressurized thermal balance with both hydrogen and steam. Comparisons are made of the reactivity and caking properties of BTC, untreated raw coal, and raw coal impregnated with established gasification catlysts. These results indicate that more than a magnitude difference in reactivity is achieved with BTC compared to the untreated coal. The effect of temperature on steam gasification and pressure on hydrogasification are discussed for BTC, raw coal, and conventionally treated coal.

2316 Factors affecting the thermal efficiency of a gasification process. Wen, C.Y.; Desai, P.R.; Lin, C.Y. (West Virginia Univ., Morgantown). *Am. Chem. Soc., Div. Fuel Chem., Prepr.*; **20**: No. 4, 109-226(1975).

From 170. American Chemical Society national meeting; Chicago, Illinois, USA (24 Aug 1975).

See CONF-750806—P2.

Advantages and disadvantages of various coal-gasification processes are discussed, and their thermal efficiencies are calculated. Discussion on the effect of the amount of methane formed in the gasifier on the overall thermal efficiency of the process and on the cost of production of high Btu gas is included. Economics of various coal-gasification processes are also examined. Suitability of the gasification process for production of either pipeline gas or electricity via combustion of low Btu gas is also discussed. The results show that the process producing a gas of higher heating value in the gasifier requires high pressure operation and would provide high thermal efficiency for the production of pipeline gas. On the other hand, the process producing gas of lower heating value in the gasifier can be carried out under low pressure and is more suitable for production of low Btu gas necessary for generation of electricity.

2317 Separation of coal hydrogasification gases by permselective membrane. Schell, W.J. (Chemico Process Plants Co., El Monte, CA). *Am. Chem. Soc., Div. Fuel Chem., Prepr.*; **20**: No. 4, 253-259(1975).

From 170. American Chemical Society national meeting; Chicago, Illinois, USA (24 Aug 1975).

See CONF-750806—P2.

A method is described that has the potential for improving the economics of coal gasification for the production of methane or methane and hydrogen. The advantages would be realized by separation of the hydrogen from the hydrogasifier effluent stream and thereby reduce the size of carbon monoxide shift reactors, lowering the volume of steam required in shift reactors, and reducing the size of waste heat recovery units. In a combined char, oil, and gas production scheme, the process would also provide sufficiently pure hydrogen gas for use in the hydrogenation of coal oil. The proposed separation method involves the use of permselective membranes that possess unusually high permeation rates and selectivity for hydrogen, thereby enabling hydrogen to be separated from coal gas mixtures in an economical and efficient manner. In addition to a description of the applications of membrane permselectivity to coal gasification, membrane gas separation theory will be discussed. Examples of pertinent separations that could be performed, such as hydrogen-carbon monoxide, hydrogen-

methane, helium-methane, carbon dioxane-methane and oxygen enrichment of air, are described. Finally, various membrane configurations that are currently employed in membrane gas separation modules, such as spiral wound and hollow fiber, are discussed in terms of application, operating variables, module size, and capacity.

2318 Combined power cycle using low Btu gas produced from the Kellogg molten salt coal gasification process. Kumar, C.A.; Fraley, L.D.; Handman, S.E. (M.W. Kellogg Co., Houston, TX). *Am. Chem. Soc., Div. Fuel Chem., Prepr.*; **20**: No. 4, 260-269(1975).

From 170. American Chemical Society national meeting; Chicago, Illinois, USA (24 Aug 1975).

See CONF-750806—P2.

In the recent past, more and more attention has been given to the production of low Btu fuel gas for utilization in a nearby power plant. Even though conventional coal-fired steam cycle power plants are capable of achieving a net heat rate as low as 8600 Btu/kW-hr, most plants operate in the 9100-10000 Btu/kW-hr. Compliance with environmental requirements on stack emissions, however, generally result in heat rates in excess of 10,000 Btu/kW-hr. Thus, there is considerable incentive to go to an alternate source of clean fuel. By incorporating minor changes in the existing combustion chambers, the gas turbine can be operated efficiently on low Btu fuel gas. Integration of the M. W. Kellogg Molten Salt Coal Gasification Process with the gas turbine-steam turbine combined power cycle system provides for an efficient method of generating electrical power from high sulfur coal while minimizing environmental pollution. The Kellogg Molten Salt Process converts the heating value of high-sulfur coal to fuel gas with a lower heating value of 100 to 150 Btu/SCF at a conversion efficiency of around 90 percent, with over 90 percent of sulfur retained by the melt. The fuel gas thus produced is cooled and scrubbed clean of contaminants in equipment integrated with the power generation and melt clean up and recycle systems. This fuel gas when used in conjunction with combined power cycle, using existing equipment, is estimated to generate power at a heat rate of around 9500 to 8500 Btu/net kW-hr depending on the ash content of the coal.

2319 Major research project to turn coal into gas. *IEEE Spectrum;* **12**: No. 3, 14(Mar 1975).

A major research project to turn coal into gas for use in producing electricity will be conducted at Northern States Power Company's Lawrence power plant near Sioux Falls, S.D. The pilot installation will use a coal gasifier to produce a gas with a heat value roughly one sixth that of pipeline natural gas. The gas will be burned in the Lawrence plant's existing boilers to produce electricity. Later, in a so-called combined-cycle process, the gas will be used to fuel a gas turbine to produce electricity and the hot exhaust from the gas turbine will be used to make steam for a conventional steam turbine to generate additional electricity. Net generating capacity of the pilot plant, after the combined cycle has been added, should be about 36 megawatts. Total cost of the project is estimated at $80 to $90 million and initial operation is set for 1979. The project is a joint venture of Northern States Power, the U.S. Office of Coal Research, and Foster Wheeler Energy Corp.

2320 Fractures induced by a contained explosion in Kemmerer coal. Hearst, J.R.; Butkovich, T.; Laine, E.; Lake, R.; Leach, D.; Lytle, J.; Sherman, J.; Snoeberger, D.; Quong, R. (Univ. of California, Livermore). *Int. J. Rock Mech. Min. Sci.*; **13**: 37-44(1976).

A cylindrical high-explosive charge, 5.5 m long, and 0.1 m in dia and weighing 59 kg, was fired with its axis vertical and its center 15 m deep in a 26 m thick subbituminous coal seam near Kemmerer, WY. The experiment attempted to associate a parameter epsilon/sub f/, the total failure-induced deviatoric strain, calculated by the one-dimensional Lagrangian computer program SOC with shot-induced fracture- and permeability-enhancement. Further purposes of the experiment were to test diagnostics for future in-situ coal gasification work. Gross effects of the explosion were increased permeability, increased fracturing, decreased sound speed, easier drilling, and migration of dye from the shot hole. These effects were found out to a radius corresponding to values of epsilon/sub f/ approximately 0.01. Values of epsilon/sub f/ of this order have been associated in the past with microscopic fracture. Subtler effects were decreased resistivity as well as changes in the character of the acoustic logs. The latter were found out to a radius corresponding to epsilon/sub f/ approximately 0.001. Diagnostic tests indicated satisfactory performance of the experimental techniques.

LIQUEFACTION

REFER ALSO TO CITATION(S) 2269, 2300, 2309, 2329, 2333, 2346, 2954, 3332, 3451

2321 (FE—1544-22) H-Coal integrated pilot plant laboratory studies. Quarterly progress report, October—December 1975. (Hydrocarbon Research, Inc., Morristown, N.J. (USA)). Contract E(49-18)-1544. 111p. Dep. NTIS $5.50.

Process Development Unit operation for the H-coal process are reported for runs 130-72 to part of 130-74. These runs were relatively successful. Detailed results are given. Methods of separating solids from the liquid product were studied in other systems (solvent precipitation, centrifugation, sedimentation). (LTN)

2322 (FE—2003-12) Chemical characterization, handling, and refining of SRC to liquid fuels. Annual report, June 1975—June 1976. Greskovich, E.J. (Air Products and Chemicals, Inc., Allentown, Pa. (USA)). 7 Jul 1976. Contract E(49-18)-2003. 28p. Dep. NTIS $4.00.

A bibliography relating to the characterization and refining of solvent-refined coal and coal-derived liquids has been prepared. Analyses and characterization tests of Wilsonville and Ft. Lewis SRC products show that they meet or exceed the low-ash, low-sulfur specifications. No significant inter- or intra-drum variations in composition occurred. Various analytical methods have been evaluated for use in characterizing SRC products: Brief results and sample data are given. The handling characteristics of SRC material are discussed: Agglomeration, sintering at or above 200°F, clogging of screens, consolidation and packing, grinding behavior, plugging burners, storage behavior, weathering, adhesion in pneumatic transport, etc. Finally, a unit is being constructed for desulfurization, denitrogenation and hydrocracking of SRC with solvent. Results of initial runs are reported. (LTN)

2323 (FE—2011-3) Catalysts for upgrading coal-derived liquids. Quarterly report, December 9, 1975—March 8, 1976. Crynes, B.L. (Oklahoma State Univ., Stillwater (USA). School of Chemical Engineering). 16 Mar 1976. Contract E(49-18)-2011. 33p. Dep. NTIS $4.00.

Work continued on the assessment of catalysts for sulfur and nitrogen removal from coal liquids. Experimental results with various catalysts are reported. Construction and pretesting of the catalyst life test unit is about 50 percent completed. The data acquisition and control computer was delivered. Final characterization and composition data are reported for the hydrocarbon plus ether fractions obtained from chromatographic separation of KWT anthracene oil and four oils from hydrotreating it. Consideration must be given to field ionization and flame-ionization detector sensitivities in order to convert ion intensities and peak areas to composition. Therefore, this project participated in determining such sensitivity data for 57 compounds pertinent to coal-liquid type mixtures. These data were then used in the analysis of known mixtures. High resolution 70-eV and low resolution field ionization mass spectra have been obtained for the acidic and neutral and basic nitrogen containing fractions from each of the five oils. These are being processed to provide characterization and composition data for the resins. (auth)

2324 (FE—2307-5) Research and development of rapid hydrogenation for coal conversion to synthetic motor fuels (Riser Cracking of Coal). First quarter report, April 1—June 30, 1976. Duncan, D.A.; Beeson, J.L.; Oberle, R.D. (Institute of Gas Technology, Chicago, Ill. (USA)). Jul 1976. Contract E(49-18)-2307. 30p. Dep. NTIS $4.00.

The bench-scale unit design was finalized and the procurement of equipment began. Two areas in the pilot plant building at IGT are being prepared for this project. An experimental plan was outlined with emphasis on the first year of operation. This plan and the bench-scale unit design were presented to, and subsequently approved by, ERDA/FE. An aerated feeding system was developed using a Plexiglas simulation. The range and consistency of the mass flow met requirements. A high-pressure version will be built in steel for the bench unit. A supply of North Dakota lignite was secured as the first feedstock through arrangements with the University of North Dakota.

2325 (ORNL/TM—5595) Coal Technology Program progress report, June 1976. (Oak Ridge National Lab., Tenn. (USA)). Aug 1976. Contract W-7405-eng-26. 36p. Dep. NTIS $4.00.

In the Hydrocarbonization Research Program, two successful experiments were completed (HC-5 and HC-6). The 80 atmosphere bench-scale hydrocarbonization system has been cancelled. In the Solids-Liquid Separations project, the bench-scale settler modifications were completed and the unit is back in operation. Six additive settling runs gave maximum settling rates com-

parable to those obtained with the lab-scale apparatus. High-Temperature Pyrolysis studies were repeated, using heating rates of 3°C/minute and 0.3°C/minute. Analysis of oils produced have shown that significantly more oil is produced by pyrolysis at the lower heating rates and that these oils have a rather narrow boiling range. The boiling range becomes progressively narrower, occurring at lower temperatures as the maximum pyrolysis temperature increases. Data has been obtained on the relative mutagenicity of the various chemical class fractions of fossil derived liquids. The atomic absorption spectrophotometer has been optimized for the direct monitoring of iron and nickel carbonyl in carbon monoxide and H_2—CO—CH_4 mixtures. We have found the detection limit for iron carbonyl in these gases to be about 1 ppB.

2326 Fischer—Tropsch process: gasoline from coal. Forney, A.J.; Haynes, W.P.; Elliott, J.J.; Zarochak, M.F. (Pittsburgh Energy Research Center). *Am. Chem. Soc., Div. Fuel Chem., Prepr.;* **20**: No. 3, 171-181(1975).

From 170. American Chemical Society national meeting; Chicago, Illinois, USA (24 Aug 1975).

See CONF-750806—P1.

The Bureau of Mines has done considerable development work in the area of synthesis of liquid fuels. At present, work is proceeding on the thesis that the most viable process would be a combined plant for the production of both synthetic oil and a substitute natural gas from coal gasification. The original work at the Bureau culminated in the development of the hot-gas-recycle system using parallel plates of steel thermal sprayed with a magnetite ore. This hot-gas-recycle system successfully solved the answers to two paramount problems of the F.T. Synthesis: (1) the satisfactory removal of heat of reaction from the catalyst surface and (2) a very low pressure drop over the catalyst bed. Present work is being directed at the tube-wall reactor system operating to determine the effect of higher system pressures (up to the 1000 psi range), various synthesis gas compositions, and catalyst additives on the product composition and distribution and on catalyst activity.

2327 Methanol from coal. Eastland, D.H. (Davy Powergas Inc., Houston, TX). *Am. Chem. Soc., Div. Fuel Chem., Prepr.;* **20**: No. 3, 191-212(1975).

From 170. American Chemical Society national meeting; Chicago, Illinois, USA (24 Aug 1975).

See CONF-750806—P1.

The manufacture of synthetic methanol from solid feedstocks is considered. A brief review is given of the developments in the industry using solid and gaseous feed-stocks. Coal gasification processes, which have been used since the early 20s are outlined and their application to current U.S. conditions described. A typical 5000 tons/day methanol from coal installation is reviewed using established low-pressure methanol synthesis technology with some current operating data and costs. Consideration is given to the effect of pressurization on the coal gasification units.

2328 Catalytic aspects of synthetic fuels from coal. Mills, G.A. (ERDA, Washington, DC). *Am. Chem. Soc., Div. Fuel Chem., Prepr.;* **20**: No. 4, 1-14(1975).

From 170. American Chemical Society national meeting; Chicago, Illinois, USA (24 Aug 1975).

See CONF-750806—P2.

New and improved catalytic systems are believed to offer the greatest technical opportunity for more selective conversion of coal to synthetic fuels at economically important lower temperatures and pressures. The author's experience in catalytic coal chemistry began by developing catalysts for refining liquids produced by coal pyrolysis — SiO_2-Al_2O_3 catalysts of low activity designed to prevent overcracking and later, Cr_2O_3-Al_2O_3 catalysts for simultaneous hydrodealkylation, desulfurization, and cracking, used in the commercial LITOL process. For direct coal conversion, an extension of techniques being developed for processing petroleum residua led to the suggestion of passing coal/oil mixtures directly over a fixed-bed of Co-Mo-Al_2O_3 catalyst and to the Bureau of Mines Synthoil Process. A different approach is to combine in the same reactor gasification ($C + H_2O$ yields $Co + H_2$) and hydrocarbon synthesis. Catalytic acceleration of the gasification reaction is required to permit a lower temperature where hydrocarbons are stable. The Synthane process partially accomplishes this. The potential for mobile, reusable, base catalysts is promising. Finally, some opinions are ventured on procedures most likely to lead to improved catalysts—determination of overall mechanism, diagnostic catalyst functional tests and provision for maintenance of catalyst activity and selectivity.

PYROLYSIS AND CRACKING

REFER ALSO TO CITATION(S) 2289, 2307, 2328

BY-PRODUCTS

2329 Catalytic synthesis of chemicals from coal. Wender, I. (Pittsburgh Energy Research Center). *Am. Chem. Soc., Div. Fuel Chem., Prepr.;* **20**: No. 4, 16-32(1975).

From 170. American Chemical Society national meeting; Chicago, Illinois, USA (24 Aug 1975).

See CONF-750806—P2.

In the not too distant future, chemicals derived from coal may supply the major portion of the feedstocks used by the chemical industry. Five general routes are available to convert coal to chemicals. The first is the traditional route: chemicals derived from coal tar obtained by the coking of coal. This is essentially noncatalytic, well known and will not be discussed. A second possibility, of limited potential, is the oxidation of coal to chemicals. A third route is via acetylene from coal. The two most important possibilities involve the gasification and the liquefaction of coal. Gasification of coal to a mixture consisting mainly of H_2 and CO (synthesis gas) could lead via a number of catalytic processes to low-molecular weight paraffins, olefins, aromatics, alcohols, and other oxygenates. Methanol from synthesis gas can be reacted to yield formaldehyde, ethanol and higher alcohols, ethylene, acetic acid, or methyl acetate. By-products tars from gasification may be processed to chemicals. The catalytic liquefaction of coal can yield a fuel oil or a low-molecular weight product, each of which could be processed further to a variety of products by additional catalytic reactions such as hydrocracking, hydrogenation, etc. The chemistry and the catalytic pathways to chemicals from coal are discussed.

PROPERTIES

REFER ALSO TO CITATION(S) 2282, 2284, 2301, 2312, 2336, 2349, 2444, 3586

2330 (FE—2233-1) Catalytic activity of coal mineral matter. Interim report, January—March 1976. Hamrin, C.E. Jr. (Kentucky Univ., Lexington (USA). Dept. of Chemical Engineering). Apr 1976. Contract E(49-18)-2233. 16p. Dep. NTIS $3.50.

A compilation of literature information and previous work at the University of Kentucky on the constituents, element concentrations, characterization, separation of components, and catalytic studies of coal mineral matter is presented in this first quarterly report. Initial project work on separating pyrites from other mineral matter components is also discussed. The objective of this study is to determine the catalytic activity of mineral matter from 8 or 10 U.S. coals using model sulfur and nitrogen compounds. A pulse microreactor connected to a gas chromatograph is the reaction system to be used. Mineral matter will be obtained by low-temperature ashing in an oxygen plasma and will be characterized by surface area, pore volume, x-ray diffraction, and thermogravimetric analysis. The effect of chemical treatment on the mineral matter and the relative importance of the components will also be investigated. Finally, samples from various points in the SRC or SRL pilot plants will also be evaluated as to catalytic activity of the mineral matter.

2331 Chemical structure analysis of coal hydrogenation products: distribution of structural parameters and application of ^{13}C NMR to structural analysis. Maekawa, Y.; Ueda, S.; Hasegawa, Y.; Nakata, Y.; Yokoyama, S.; Yoshida, Y. (Government Industrial Development Lab., Hokkaido, Japan). *Am. Chem. Soc., Div. Fuel Chem., Prepr.;* **20**: No. 3, 1-6(1975).

From 170. American Chemical Society national meeting; Chicago, Illinois, USA (24 Aug 1975).

See CONF-750806—P1.

In order to study the chemical structure of coal, Yubari coal was subjected to mild hydrogenation and converted to solvent-soluble products. The reaction time was changed from 26 to 206 min. The solvent-soluble product was extracted with n-hexane, benzene, and pyridine successively, which resulted in 5 fractions; oil-1, oil-2, asphaltene, pyridine solubles-1, and pyridine solubles-2. Regarding these hydrogenation reaction products ultimate analysis, high resolution NMR spectroscopy, and molecular weight measurement were carried out and the chemical reaction in the Yubari coal in the course of hydrogenation was followed. From the above structural analysis of the average structural unit was conducted. This was followed by fractionation of the component oil-2 which corresponding to monomers, by GPC and each fraction was measured for ^1H-NMR, ^{13}C-NMR, GPC, VPO, etc., and the distribution of structural parameters was studied. The findings were correlated and the chemical structure of Yubari coal was tentatively set forth.

2332 Inferences on the structure of coal: ^{13}C NMR and ir spectroscopy. Franz, J.A.; Morrey, J.R.; Campbell, J.A.; Tingey, G.L.; Pugmire, R.J.; Grant, D.M. (Battelle Memorial Inst., Richland, WA). *Am. Chem. Soc., Div. Fuel Chem., Prepr.;* **20**: No. 3, 12-18(1975).

From 170. American Chemical Society national meeting; Chicago, Illinois, USA (24 Aug 1975).

See CONF-750806—P1.

The characterization of coal by ^{13}C nmr has been severely limited by the low solubility of coal or by the lack of correlation of the structures of the products of destructive dissolution techniques with the original coal structure. To overcome these difficulties the techniques of acid-catalyzed depolymerization of coal with phenol in combination with a ^{14}C labeling study to follow the course of phenol during depolymerization were used. Molecular solutions of significant proportions of the total coal mass were obtained. In a general discussion of experimental procedures and of the resulting spectra of several coals, spectral data (which indicate largely aromatic structures for the coals studied) are interpreted in terms of model systems containing polynuclear aromatic, heteroaromatic, quinoidal, and other functionalities. Partially Relaxed Fourier Transform (PRFT) techniques used to differentiate between quarternary and substituted carbons are discussed, and the depolymerization ^{13}C spectroscopy technique is evaluated for utility in coal analysis for industrial uses.

2333 Deuterium magnetic resonance spectrometry as a tracer tool in coal liquefaction processes. Schweighardt, F.K.; Bockrath, B.C.; Friedel, R.A.; Retcofsky, H.L. (Pittsburgh Energy Research Center). *Anal. Chem.;* **48**: No. 8, 1254-1255(Jul 1976).

Deuterium magnetic resonance (^2H NMR) was used as a means for determining the distribution of incorporated hydrogen among various organic structures in coal liquids. The centrifuged liquid product from a SYNTHOIL run was deuterated and the labeled sites were identified by the use of ^2H NMR correlation spectra of the liquid and several of its fractions. The hydrogen and deuterium distributions were tabulated. (DDA)

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 3804, 3811

2334 (BM-RI—7774) **Sulfur dioxide emission control by hydrogen sulfide reaction in aqueous solution: the citrate system.** Rosenbaum, J.B. (Bureau of Mines, Washington, D.C. (USA)). 1973. vp. Bureau of Mines, Washington, DC.

Prolonged laboratory and limited pilot-plant tests have shown that the Bureau of Mines buffered SO_2-H_2S process is capable of removing 95 to 99 percent of the SO_2 from industrial waste gases. Most of the SO_2 is converted to elemental sulfur; only about 1 percent converted to sulfate. The process and mechanism are described.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 2348, 3314, 3873, 3874

2335 Fort Union coal field symposium, Billings, Montana, April 25—26, 1975. Volume 2. Aquatic ecosystems section. Clark, W.F. (ed.). Billings, MT; Eastern Montana College (1975). 136p. (CONF-7504100—P2). $8.75.

From Proceedings of the Fort Union coal field; Billings, Montana, United States of America (USA) (25 Apr 1975).

Vol. 2 of the proceedings of the symposium, sponsored by the Montana Academy of Sciences and held at Eastern Montana College, Billings, includes 12 papers, each indexed separately for the ERDA Energy Data Base. The papers involve studies of specific river aquatic ecosystems and their changes along the rivers, seasonal variations, species diversity, etc. as a base for measuring the effects of coal mining, power plants, and coal-gasification plants resulting from water withdrawal, waste water, and waste heat effluents. Some papers deal with hydrology and water resources availability and planning in the area. (LTN)

2336 Fort Union coal field symposium, Billings, Montana, April 25—26, 1975. Volume 3. Reclamation section. Clark, W.F. (ed.). Billings, MT; Eastern Missouri College (1975). 138p. (CONF-7504100—P3). $8.75.

From Proceedings of the Fort Union coal field; Billings, Montana, United States of America (USA) (25 Apr 1975).

Vol. 3 of the proceedings of the symposium sponsored by the Montana Academy of Sciences and held at Eastern Montana College, Billings, includes 12 papers indexed separately for the ERDA Energy Data Base. The papers involve spoil banks from strip mining coal or lignite, their physical and chemical characteristics, and factors associated with their revegetation. The latter includes surface configuration to trap precipitation, alleviation of adverse characteristics (necessary in some areas), fertilizers, addition of top soil, mulches, and selection of grasses and shrubs. One paper is devoted to the porosity and permeability of spoil banks and the water quality of the groundwater in them. One paper reports on the vertical and lateral distribution of sulfur and 14 trace elements in the Rosebud and McKay seams of the Coalstrip coal field. One paper is devoted to the availability of water. (LTN)

2337 Fort Union coal field symposium, Billings, Montana, April 25—26, 1975. Volume 5. Terrestrial ecosystems section. Clark, W.F. (ed.). Billings, MT; Eastern Missouri College (1975). 197p. (CONF-7504100—P5). $8.75.

From Proceedings of the Fort Union coal field; Billings, Montana, United States of America (USA) (25 Apr 1975).

Vol. 5 of the proceedings of the symposium sponsored by the Montana Academy of Sciences and held at Eastern Montana College, Billings, Montana on Apr. 25-6, 1973 contains 16 papers indexed individually for the Energy Data Base. The papers involve the terrestrial ecosystem, in particular the development of plant, animal, bird and insect distribution and inventories to provide baseline information from which the effects of strip mining and pollution from a coal-fired power plant can be measured. The possibilities of certain indicator species serving as biological indicators of pollution is discussed, especially the relative merits of plants, animals, birds and insects. A few papers deal with the effects of the air pollution expected from the coal-fired power plant (sulfur oxides, nitrogen oxides fluorides and many trace elements (based on analyses of the coal)). Research programs to monitor the effects of air pollution are described, including plant damage studies, remote sensing, infrared photography, etc. The possibilities of the air pollution (heat, moisture and particulates) for modifying the arid climate are discussed. Land use and terrestrial ecosystem management and planning are treated briefly. (LTN)

RESERVES AND EXPLORATION

REFER ALSO TO CITATION(S) 2359, 2387

2338 Coal development in North Dakota, Montana, and Wyoming. Gronhovd, G.H.; Kube, W.R. (Bureau of Mines, Grand Forks, ND). pp 11-46 of In Fuels: a geological appraisal. Parslow, G.R. (ed.). Regina, Saskatchewan; Saskatchewan Geological Society (1975).

From Symposium on fuels) a geological appraisal; Regina, Saskatchewan, Canada (7 Nov 1974).

The status of coal development in the three-state area is reviewed in regards to the energy situation. Estimated reserves are classified according to rank, sulfur content, and possible mining techniques. Differences and similarities in properties of lignitic and subbituminous coals are characterized and their influence on end use discussed. Historical production patterns and recovery methods are summarized, and estimates of future production levels presented. Problem areas in mining and land reclamation are discussed. Special emphasis is given to coal-fired electrical generating stations with respect to present operations, expansion plans, and problems related to combustion to low-rank fossil fuels. Plans for coal gasification complexes for production of substitute natural gas are discussed in relation to coal consumption, water usage, and environmental impact.

2339 Lignite coal resources of southern Saskatchewan. Broughton, P.L.; Irvine, J.A.; Whitaker, S.H. (Dept. of Mineral Resources, Regina, Saskatchewan). pp 81-94 of In Fuels: a geological appraisal. Parslow, G.R. (ed.). Regina, Saskatchewan; Saskatchewan Geological Society (1975).

From Symposium on fuels) a geological appraisal; Regina, Saskatchewan, Canada (7 Nov 1974).

The estimated lignite resources of southern Saskatchewan have been evaluated by a two-year borehole drilling program. Approximately 700 boreholes were drilled in this program. Information from an additional 500 boreholes of a related provincial coal evaluation program are utilized in this resource estimate to provide a density of control ranging from $^1/_2$ mile to 2 mile centers. Included in the resource calculation are all coal seams that are at least 5 feet thick and within 150 feet of surface or 3 to 5 feet thick provided the overburden/seam ratio is less than or equal to 15 linear feet of overburden to 1 linear foot of coal. Seam partings of clastic material and coal less than one foot thick within a seam are not included in the resource. Resources are reported for the four

major coal-basins: Estevan, Willow Bunch, Wood Mountain, and Shaunavon. Although some previously unknown deposits of lignite were discovered during this program, estimates of the total resources have been substantially reduced relative to previous published calculations.

2340 Evaluation of borehole sampling methods applicable to lignite resource exploration. Irvine, J.A. (Geological Survey of Canada, Calgary, Alberta); Whitaker, S.H.; Broughton, P.L.; Tibbets, T.E. pp 203-227 of In Fuels: a geological appraisal. Parslow, G.R. (ed.). Regina, Saskatchewan; Saskatchewan Geological Society (1975).

From Symposium on fuels) a geological appraisal; Regina, Saskatchewan, Canada (7 Nov 1974).

The reliability of several borehole sampling methods was tested for application to lignite-bearing strata in the shallow subsurface. The experimental program in southern Saskatchewan used normal rotary drilling, reverse-circulation drilling with dual-wall pipe, continuous rotary core drilling and side-wall coring to obtain lignite samples for proximate and ultimate analyses. The results were compared to samples collected from an adjacent open pit mine face. Gamma-gamma density logs obtained in the experimental boreholes are correlated to the analytical results. Chemical analyses of reverse circulation samples compare more favorably with those of mine face samples than do the analyses of samples obtained by other drilling techniques. Reverse-circulation drilling techniques are capable of obtaining samples under lost circulation conditions where normal rotary drilling methods are unsuccessful. Results indicate that reverse-circulation drilling employing top drive and drag drill bits would be the favored technique where accurate chemical analyses of the samples are required or where lost circulation conditions prevailed. These results should be applicable to the evaluation of lignite resources throughout the northern Great Plains region.

MINING

REFER ALSO TO CITATION(S) 2338, 2352, 2353, 2354

2341 (BM-IC—8632) **Basic estimated capital investment and operating costs for underground bituminous coal mines: mines with annual production of 1.06 to 4.99 million tons from a 72-inch coalbed.** Katell, S.; Hemingway, E.L. (Bureau of Mines, Morgantown, W.Va. (USA)). 1974. 41p. Bureau of Mines, Washington, DC.

This study estimates capital investment, operating costs, and selling prices for four underground bituminous mines producing coal with annual production ranging from 1.06 to 4.99 million tons. It is assumed that the mines have a 20-year life. Wages and union welfare payments are considered as of November 12, 1973, under the Bituminous Wage Agreement of 1971, and costs for material and equipment are based on 1973 indexes. Initial capital investment ranges from $12,540,700 for the 1.06-million-ton-per-year (MM tpy) mine to $44,720,500 for the 4.99 MM tpy mine. Total capital investment ranges from $21,850,700 to $75,693,500 for the same mines. Corresponding selling prices for the coal range from $8.76 to $7.53 per ton, assuming a 12-percent discounted cash flow rate of return after Federal income taxes.

2342 (BM-RI—7858) **Chemical analysis of slickensides from coal mine roof shale.** Savanick, G.A.; Cabaniss, R.W. (Bureau of Mines, Twin Cities, Minn. (USA). Twin Cities Mining Research Center). 1974. 19p. Bureau of Mines, Washington, DC.

Coal mine roof shales fracture preferentially at slickensided surfaces because of weak or nonexistent adhesion between two slickensided rock surfaces. The purpose of this Bureau of Mines research was to characterize chemically the thin film of smooth, glossy material that makes up the slickenside. This material was analyzed by electron spectroscopy and ion scattering spectrometry while in place on the rock surface and by standard methods of quantitative chemical analysis on concentrate removed from the rock. These analyses showed that the chemistry and mineralogy of the slickensides are similar to that of the adjacent shale.

2343 (BM-RI—8097) **Rotary drilling holes in coalbeds for degasification.** Cervik, J.; Fields, H.H.; Aul, G.N. (Bureau of Mines, Washington, D.C. (USA)). 1975. 21p. Bureau of Mines, Washington, DC.

Coal is a soft and brittle material. Drilling rates in the Pittsburgh coalbed using a drag bit exceed 3 ft/min at 2,500-pound thrust. However, maintaining the bit on a horizontal trajectory or parallel to bedding planes to attain lengths of 1,000 feet is difficult. This Bureau of Mines report presents a drill string configuration that can be guided through the coalbed. The angle of the borehole is measured periodically and by proper combinations of bit thrust and rotational speed (r/min), bit trajectory can be lifted or dropped to keep the bit in the coalbed. An example of a hole drilled to 2,126 feet is presented to show levels of thrust and rotational speed used to lift or drop the bit, the seemingly unexplainable events that occur, and the strategy used during drilling. Thrust levels during drilling range from 600 to 2,500 pounds. Hydraulic motors powered by a 30-hp, 440-volt motor provide ample power for drilling horizontal holes 2,000 feet long.

2344 (BM-RI—8107) **Coal mine combustion products: conveyor belts.** Hartstein, A.M.; Forshey, D.R. (Bureau of Mines, Washington, D.C. (USA)). 1976. 15p. Bureau of Mines, Washington, DC.

The Federal Bureau of Mines, under a contract with Ultrasystems, Inc., investigated the thermal oxidative degradation characteristics of conveyor belts used in underground mines. This included the determination of smoke evolution, glow characteristics, char yields, and the identification and quantification of all volatile decomposition products in the form of gram of specific product formed per gram of belt sample tested. In addition to these investigations, degradation studies were conducted on some pure ingredients used in conveyor-belt formulations. Three basic classes of belts were investigated: neoprene, polyvinyl chloride, and styrene-butadiene rubber compositions. The studies indicate that styrene-butadiene-based belts exhibit good flame resistance and are the least hazardous in regard to overall formation of toxic decomposition products. Under this program, thermogravimetric analysis was definitely established as a method of material differentiation.

2345 (NP—20867) **Illinois lands surface mined for coal.** Haynes, R.J.; Klimstra, W.D. (Southern Illinois Univ., Carbondale (USA). Cooperative Wildlife Research Lab.). Jun 1975. 213p. Southern Illinois Univ., Carbondale.

All lands in Illinois affected by surface mining for coal as of 30 June 1971 were surveyed during 1970 and 1971 to update existing knowledge of the acreage, ownership, condition, and utilization of the lands. Data are presented tabularly for management regions and counties in which there is surface coal mining. An extensive list of literature cited is included. (EJH)

2346 (UCRL-Trans—11109) **Chemical methods for mining coal.** Yamazaki, T. Translated from *Nippon Kogyo Kaishi;* **76**: No. 869, 769-772(Nov 1960). 16p. Dep. NTIS $3.50.

Changes in the structure of coal utilization are occurring and present coal products are not particularly suitable for these new uses, i.e., for chemical processing. Petroleum and waste gas have almost completely displaced coal as a source of chemicals. Even the advantages of solid fuels are now questioned, since liquids are more easily controlled by automatic methods. In comparing the coal mining and petroleum industries, the author suggests that the processes of coal mining, coal preparation and coal liquefaction are necessary before a product equivalent to crude oil is obtained. Thus, a decline for the coal industry is forecast unless the overall merit of coal can be improved by the development of profitable new technologies and improved efficiency. The improvements required cannot be achieved by conventional mechanical coal mining methods. Chemical mining methods are proposed, namely in-situ approaches, involving hydrogenolysis, solvent extraction, alkali resolution, gasification, etc., of coal seams (sometimes combinations of these processes are recommended). Since high temperature (about 450°C) and high pressure (greater than 200 atmospheres) are usually required, the methods may be more applicable to the deeper seams. (LTN)

2347 Fort Union coal field symposium, Billings, Montana, April 25—26, 1975. Volume 1. Table of contents of all 5 volumes, cross-reference index of authors and subjects, papers of the general session, and papers of the administration section. Clark, W.F. (ed.). Billings, MT; Eastern Montana College (1975). 155p. (CONF-7504100—P1). $8.75.

From Proceedings of the Fort Union coal field; Billings, Montana, United States of America (USA) (25 Apr 1975).

Vol. 1 of the proceedings of the symposium, sponsored by the Montana Academy of Sciences and held at Eastern Montana College, Billings, includes 18 papers, each indexed separately for the ERDA Energy Date Base. The papers involve planning and preparations for strip mining coal in the U. S. Great Northern Plains area and the problems with State and U. S. Dept. of the Interior policies and regulations, complicated by Indian ownership in some cases, and different surface and mineral rights ownership in others. Ultimately, a massive growth in coal mining in this area is expected, including processing such as coal gasification and liquefaction, but such growth is showed at present by the many complex policy and regulatory problems encountered. (LTN)

2348 Fort Union coal field symposium, Billings, Montana, April 25—26, 1975. Volume 4. Social impact section. Clark, W.F. (ed.). Billings, MT; Eastern Missouri College (1975). 138p. (CONF-7504100—P4). $8.75.

From Proceedings of the Fort Union coal field; Billings, Montana, United States of America (USA) (25 Apr 1975).

Vol. 4 of the proceedings of the symposium sponsored by the Montana Academy of Sciences and held at Eastern Montana College, Billings, contains 13 papers, each indexed separately for the ERDA Energy Data Base. The papers involve social and socio-economic effects that might result from a rapid development of the coal resources in the area. In several cases, attitudes and characteristics of workers and residents are analyzed. There is evident concern about a "boom-and-bust" type of development, also concern about getting the best results for local, state, and national interests. A report on a "Montana Energy Policy Study and the Fort Union Coal Basin" is partucularly significant. (LTN)

TRANSPORT AND HANDLING

REFER ALSO TO CITATION(S) 2267, 2268, 2282, 2284, 2346, 2348

2349 (BM-RI—7887) **Laboratory determination of factors affecting storage of North Dakota lignite: computer simulation of spontaneous heating.** Sondreal, E.A.; Ellman, R.C. (Bureau of Mines, Grand Forks, N.Dak. (USA). Grand Forks Energy Research Lab.). 1974. 91p. Dep. NTIS $5.00.

Material and energy balances for stockpiled lignite were calculated by computer simulation techniques to determine the occurrence of spontaneous heating. Data on properties of lignite which affect spontaneous heating were required. In some cases, best values from reported data were utilized; in other cases, new data were developed. These include specific studies on the rate and conditions that influence oxidation, heat of oxidation, heat of wetting, specific heat, thermal conductivity, and permeability of stockpiles to air. These data are presented and discussed in detail for possible application to other studies. Results of computer simulations confirm past field experience on the storage of lignite containing as-mined moisture, and predict a greater risk of heat occurrence in stockpiles of dried lignite where experience is lacking. Successful storage was predicted for dried lignite of 20 percent moisture content, if it were cooled after drying and compacted to an interparticle void fraction of 9 percent (bulk density of 67 lb/cu ft) compared to 10 percent void fraction (72 lb/cu ft) for as-mined lignite.

COMBUSTION

REFER ALSO TO CITATION(S) 2272, 2284

2350 Fluidized-bed coal burner: a new look. Krause, C. *Oak Ridge Natl. Lab. Rev.*; 9: No. 3, 1-8(Sum 1976).

The possibilities of a proposed combined cycle power plant with fluidized-bed combustion of coal and potassium or helium and steam vapor cycles are discussed. Due to the fluidized-bed combustion (with limestone in the bed), the system should meet EPA's standards for SO2, NOX and ash emissions. Due to the combined cycle feature, the efficiency in producing electricity would be about 50 percent compared to 35 to 40 percent for steam power plants. Process heat can be drawn off at temperatures up to about 815°C (if preferred to power production). The MIVS program and potassium vapor studies on which the above idea is based are reviewed briefly and then the proposed binary cycle concept is described in detail. The use of the potassium cycle permits the use of higher temperature (and therefore higher Carnot efficiency) without the very high pressures and materials problems that would arise with steam at such temperatures. Waste heat is to be used for hot water heating or for heating and air conditioning. Some engineering problems are discussed briefly. (LTN)

2351 Pulverized char combustion in a laboratory scale furnace. Essenhigh, R.H.; Cogoli, J.G. (Pennsylvania State Univ., University Park). *Am. Chem. Soc., Div. Fuel Chem., Prepr.*; **20**: No. 3, 134-146(1975).

From 170. American Chemical Society national meeting; Chicago, Illinois, USA (24 Aug 1975).

See CONF-750806—P1.

A number of low-volatile-matter content fuels have been burned in a plane-flame laboratory furnace, with the fuels exhibiting combustion characteristics ranging from those similar to anthracite coals to those very nearly like bituminous coal. The chars tested to date have fallen into two groups according to reactivity and related combustion performance. The information available about the chars tested indicates that the highly reactive chars possess much larger accessible surface areas than the unreactive chars. Method of char preparation seems to be the most important factor determining resultant char reactivity, with parent coal rank also having considerable influence. In the experiments performed in this laboratory, no supplementary fuel or air preheat was utilized. Experiments performed elsewhere have previously needed air preheat and/or supplementary fuel to stabilize flames using some of the same chars. Information concerning the relative combustion performance of a char and an anthracite coal, as derived from plane-flame furnace experiments conducted in this laboratory, has already been applied with success to an anthracite burning utility boiler. The question of whether a given char can be burned in existing bituminous coal boilers without modifications is critical to the economic feasibility of planned coal gasification and liquefaction plants.

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 2341

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 2344, 4006

2352 (BM-RI—7930) **Incendivity of some coal-cutter materials by impact-abrasion in air-methane.** Blickensderfer, R.; Deardorff, D.K.; Kelley, J.E. (Bureau of Mines, Albany, Oreg. (USA). Albany Metallurgy Research Center). 1974. 23p. Bureau of Mines, Washington, DC.

Test equipment that simulated frictional impacts between coal-cutter bits and mineral inclusions at a coal face during operation of a continuous coal mining machine was used to study the incendivity of impacts between various rocks, metals, and hard-metal alloys in an explosive mixture of air-7 pct natural gas. Quartzitic sandstone was found to be the most incendive of several rocks tested. Limestone concretions from a coal seam, known locally as "sulfur balls," sparked furiously but were not incendive. Among the metals tested, the type of steel used in commercial coal-cutter tools was the most incendive material tested. A 17-4PH stainless steel was less incendive and appears to be the most promising high-strength steel alloy, reasonably economical, for use in coal-cutter bits. Some hard-metal alloys, primarily titanium and zirconium diboride composites, were also evaluated as possible replacements for the conventional cobalt-bonded tungsten carbide used in the tip of coal-cutter bits. The metal-bonded diborides were generally less incendive (but more brittle) than the conventional tungsten carbide. Carbonitride coatings on tool bits were also tested but found to have no advantage. The source of ignition during frictional impact between metal and rock was studied. Immediately after impact, a yellow flash was observed and a smear of metal near its melting point occurred on the rock. This hotspot on the rock, rather than the yellow flash or sparks or metal fragments, was observed to be the cause of the ignition.

2353 (BM-RI—7991) **Ventilation eddy zones at a model coal mine working face.** Kissell, F.N.; Bielicki, R.J. (Bureau of Mines, Pittsburgh, Pa. (USA). Pittsburgh Mining and Safety Research Center). 1974. 14p. Bureau of Mines, Washington, DC.

Tracer gas decay curves were obtained in a full-scale model coal mine working face area. The concentration of tracer gas was found to decay in exponential fashion but with a change in slope. This change in slope is attributed to eddy zones in the face area. A simple theory was developed that allows one to calculate the approximate amount of gas in the eddy zones and thus estimate the size of the eddy zones.

2354 (BM-TPR—96) **Effect of location and type of water sprays for respirable dust suppression on a continuous-mining machine. Technical progress report.** Matta, J.E. (Bureau of Mines, Pittsburgh, Pa. (USA). Pittsburgh Mining and Safety Research Center). May 1976. 11p. Bureau of Mines, Washington, DC.

A field study was conducted to investigate the suppression of respirable dust by water sprays on a continuous-mining machine. Determining the importance of the top and bottom sprays for two types of spray nozzles was emphasized. Results showed, at a 90-pct confidence level, that (1) at least 70 percent of the dust was generated during the sump cut, even though nearly half of the coal was mined during the downshear operation, (2) the water sprays on the top of the boom had little effect in suppressing respirable dust, and (3) B.D. 5 spray nozzles mounted

beneath the boom reduced dust at least 33 percent more than B.D. 5 sprays mounted on top of the boom. A single-cut technique was developed that gave good reproducibility for replicate cuts (coefficient of variation of 20 percent).

REGULATIONS

REFER ALSO TO CITATION(S) 2347, 3345

PETROLEUM

2355 (TID/BERC—38) **Crude petroleum, petroleum products, and natural gas liquids in P.A.D. District V: December 1974.** (Bureau of Mines, Washington, D.C. (USA)). 16 Apr 1975. 7p. TIC.

Data compilations are presented for the production, demand, and inventories for December 1974. (JSR)

2356 (TID/BERC—41) **Crude petroleum, petroleum products, and natural gas liquids: December 1974.** (Bureau of Mines, Washington, D.C. (USA)). 18 Apr 1975. 35p. TIC.

Data compilations are presented on the production of crude petroluem, products of natural gas processing plants, and the production and sales of fuels and refined products. (JSR)

2357 (TID/BERC—42) **Crude petroleum, petroleum products, and natural gas liquids: 1973 (final summary).** (Bureau of Mines, Washington, D.C. (USA)). 14 Feb 1975. 45p. TIC.

Data tabulations are presented for the production and processing of crude petroleum, products from natural gas processing plants, and the production and sales of fuels and refined products. (JSR)

RESERVES

2358 (UCRL—52000-76-7, pp 1-4) **Forecasting the world's crude oil supply.** Borg, I.Y. Jul 1976.

In Energy and technology review.

A recent LLL study indicates the distinct possibility of a temporary oil price break in the early 1980's. The long-range scenario remains unchanged: diminishing crude oil resources and steeply rising prices followed by elimination of oil as a feasible energy source for high-volume markets (e.g., transportation and electrical production). Whether or not the world price of crude oil softens, we consider the continued development of alternative energy sources to be imperative.

EXPLORATION

REFER ALSO TO CITATION(S) 2387, 4029

2359 Fuels: a geological appraisal. Proceedings of a symposium held at Regina, Saskatchewan, Canada, 7—8 November 1974. Parslow, G.R. (ed.). Regina, Saskatchewan; Saskatchewan Geological Society (1975). 244p. (CONF-741192—).

From Symposium on fuels) a geological appraisal; Regina, Saskatchewan, Canada (7 Nov 1974).

Individual papers were abstracted and indexed. (LK)

2360 Relationship between hydrocarbon accumulations and basement structural elements in the northern Williston Basin. Kent, D.M. (Univ. of Regina, Saskatchewan). pp 63-79 of In Fuels: a geological appraisal. Parslow, G.R. (ed.). Regina, Saskatchewan; Saskatchewan Geological Society (1975).

From Symposium on fuels) a geological appraisal; Regina, Saskatchewan, Canada (7 Nov 1974).

In the past 23 years since oil was first discovered in the Mississippian rocks of Manitoba enough subsurface information concerning the Williston Basin has been accumulated so that a fairly reliable assessment can be made of the trapping mechanisms for the various reservoirs. A large portion of these reservoirs are stratigraphic traps, but in many instances structure has played an important role in their formation. There appear to be three ways by which structure has been effective in forming these hydrocarbon reservoirs: (1) by producing secondary porosity, (2) acting as a depositional site for the accumulation of porous clastic rocks, (3) by being the mechanism by which porous rocks were draped over a structural positive feature. Many of these structures may be due to events or features occurring within the Phanerozoic sequence; as an example buried topographic positive elements on the Paleozoic erosion surface appear to have been the foci for the accumulation of some Cretaceous sand bodies in west-central Saskatchewan. In contrast other structures have trends that suggest they may be controlled by deep-seated structural elements and there is evidence that reservoirs in Ordovician, Devonian, Mississippian, Jurassic and Cretaceous rocks were affected by them.

2361 Astroblemes in the Williston Basin. Sawatzky, H.B. (Francana Oil and Gas Ltd., Calgary, Alberta). pp 95-117 of In Fuels: a geological appraisal. Parslow, G.R. (ed.). Regina, Saskatchewan; Saskatchewan Geological Society (1975).

From Symposium on fuels) a geological appraisal; Regina, Saskatchewan, Canada (7 Nov 1974).

This paper outlines, with the aid of key maps, cross sections and seismic record sections, the basic parameters which allow us to identify three subsurface structures in the Williston Basin as fossil impact craters (Viewfield, Saskatchewan T.7, R.8, W2M; Hartney, Manitoba T.5, R.24, W1M; Red Wing Creek, North Dakota, T148N-101W). It is hoped this will lend further credence to the idea expressed in an earlier paper that astroblemes may be the primary cause behind the existence of at least some of the sombrero features found in the Williston Basin to date.

2362 Hydrocarbon potential of the Bighorn Group (Ordovician) in southern Saskatchewan. Kendall, A.C. (Dept. of Mineral Resources, Regina, Saskatchewan). pp 125-148 of In Fuels: a geological appraisal. Parslow, G.R. (ed.). Regina, Saskatchewan; Saskatchewan Geological Society (1975).

From Symposium on fuels) a geological appraisal; Regina, Saskatchewan, Canada (7 Nov 1974).

The predominantly carbonate succession of Ordovician age in southern Saskatchewan (Bighorn Group) comprises four formations: in ascending order these are the Yeoman, Herald, Stony Mountain and Stonewall Formations, and reaches a thickness of 736 feet in the southeast of the province. The Yeoman and Herald units are considered to possess greatest hydrocarbon potential. The Yeoman is largely composed of partially to wholly dolomitized, mottled biomicrites. Organic material in the Yeoman is considered a source for much of the Lower Paleozoic hydrocarbons in the Williston Basin. Hydrocarbon production within the Saskatchewan Bighorn Group has been confined to a 30-foot microdolomite sequence at the base of the Herald Formation. This unit together with an overlying anhydrite, are distinguished as the Lake Alma Member. Significant porosity and permeability in Lake Alma dolomites are localized, patchily developed and may be structurally controlled—apparently they are independent to fine stratigraphic/facies control. Discoveries in neighbouring northern North Dakota and northeast Montana suggest that Bighorn carbonates immediately north of the International border are prime exploration targets and that production might be found in stratigraphic units other than the basal Herald; notably the uppermost Yeoman.

2363 Hummingbird structure, Saskatchewan, single vs multiple stage salt solution-collapse. Bishop, R.A. (Amoco Production Co., Denver). pp 179-197 of In Fuels: a geological appraisal. Parslow, G.R. (ed.). Regina, Saskatchewan; Saskatchewan Geological Society (1975).

From Symposium on fuels) a geological appraisal; Regina, Saskatchewan, Canada (7 Nov 1974).

The vertical relief of the Hummingbird dome is greatest in Mississippian carbonates, and becomes progressively less downward through Devonian carbonates until at the base of the Devonian it is essentially flat. Mesozoic clastics above the Mississippian unconformity are also flat-lying. It has been widely believed that the Hummingbird structure resulted from local multiple-stage salt solution and collapse, with concurrent compensating sea floor deposition into a salt-bottomed sink, and that during the hiatus at the end of the Paleozoic, regional salt solution and collapse created a domal structure because of the extra Devonian deposition. This paper will attempt to show how the Hummingbird structure could have been created by a single period of salt solution and collapse with the additional section made up of brecciated rock. The analogy of a neatly stacked pile of bricks on a solid base compared with a similar stack on a sagging and collapsing base, with local areas of upwarp due to jamming, may illustrate the point. The discussion shows that the multiple stage hypothesis call upon such a number of coincidences that it loses credibility in favor of the single stage hypothesis.

2364 Uinta tertiary, mesozoic prospects need look. Campbell, J.A.; Ritzma, H.R. (Utah Geological and Mineral Survey, Salt Lake City). *Oil Gas J.*; **74**: No. 19, 110-114(10 May 1976).

Field and subsurface evidence confirms that the structural geometry of the south flank of the Uinta Mountain uplift is characterized by a major upthrust fault, similar to those typical of the

Rocky Mountains province east of the folded belt. Subsidiary folds and upturned strata associated with this structural style provide favorable conditions for the entrapment of petroleum in a relatively narrow zone along the entire south side of the Uinta uplift. About 1.2 billion bbl of oil in eight oil-impregnated rock deposits appears to represent leakage from such traps. Available data from existing wells and seismic exploration indicate that such prospects in Tertiary and Mesozoic strata may occur from less than 6,000 ft to at least 25,000 ft below the surface.

DRILLING AND PRODUCTION

2365 (BERC—0003-8) **El Dorado Micellar: Polymer Project. Technical letter for March 1976.** (Cities Service Oil Co., New York (USA)). 1976. Contract E(34-1)-0003. 30p. Dep. NTIS $4.00.

The well stimulation program that was initiated last month has continued to appear quite favorable. The program was extended to include all injection wells operating below 100 barrels per day. A total of 20,280 and 19,160 barrels of pretreatment fluids were injected into the Chesney and Hegberg pattern, respectively. Work concerned with the quality of injection water has continued on site and in the laboratory. Additional information has been received about the formulation of the Shell system. Laboratory flow experiments, modeling and other work directed toward questions raised by study of this information have been initiated. Meetings were held with representatives of Union and Witco to discuss the blending and specifications for petroleum sulfonates used in the Union process. Mobility was the topic of a joint meeting with Union and Shell. As a result of the joint meeting, additional relative permeability work has been undertaken. Many aspects of the Union design were reviewed in a Cities Service—Union Oil meeting on March 24. The streamline and front tracking model has been documented using comment statements inserted within the program listing. This model has been used to compare sweep for various patterns and operating conditions. Polymer slug simulation has continued.

2366 (CONF-750414—2) **Stress analysis of hydraulic fracturing operations in layered granular media.** GangaRao, H.V.S.; Advani, S.H.; Shuck, L.Z.; Chang, H.Y. (Energy Research and Development Administration, Morgantown, W.Va. (USA). Morgantown Energy Research Center). 1975. 26p. Dep. NTIS $4.00.

From ASCE national structural engineering convention; New Orleans, Louisiana, USA (14 Apr 1975).

The paper deals with the determination of basic two- and three-dimensional stress distribution patterns in infinite single- and multi-layered, granular media during hydraulic pressure grouting. A majority of previous publications have tended to concentrate on simplified direct methods in which the vicinity of crack tip is defined with a large number of finite elements. Due to the inherent singular characteristics of strains in the vicinity of the crack tip, the present method superimposes the results of highly refined crack tip elements on the results of coarser, but conventional, finite element system. Two dimensional finite element models simulating hydraulic fracturing conditions are given using STRUDL II and NASTRAN computer programs. Corresponding experimental model results for validation of analytical model for far field and crack tip stresses are also presented. In addition, three dimensional finite element model representations for vertical and horizontal fracture configurations are investigated. Analysis of hydraulic fracture criteria is based on the stresses near the fracture zone. The results are compared with the selected previous work.

2367 (ERDA-tr—163) **Treatment of injection waters for secondary recovery.** Peinado, M. Translated from *Rev. Inst. Fr. Pet.*; **20**: No. 2, 280-290(1965). 19p. Dep. NTIS $3.50.

The use of water, which is compatible both with itself and with the formations injected, is one of the essential conditions for the satisfactory secondary recovery of the oil in a reservoir. Actually, this water must not cause either a reduction in the permeability of the zone in question or corrosion in the production installations. As a result, the substances in suspension in the water and the corrosive dissolved gas must be eliminated and the formation of insoluble mineral precipitates and deposits of bacterial origin must be prevented, as must the swelling of in situ clay. Treatments of injection water can thus be physical, chemical, or biological. The present article is mainly concerned with chemical treatments and shows that they no longer pose a problem, except perhaps that of improving injectivity by the use of surface agents and organic polymers.

2368 **Selective placement of fluids in a fracture by controlling density and viscosity.** Fredrickson, S.E.; Broaddus, G.C. *J. Pet. Technol.*; **28**: 597-602(May 1976).

From SPE-AIME 50. annual Fall technical conference and exhibition; Dallas, TX, USA (28 Sep 1975).

Preflushes and overflushes are commonly used in fracture acidizing. While attention is generally focused on viscosity in designing treatments, fluid density has not been considered previously. This paper presents information obtained from field treatments and from model studies on the effect of fluid density using a vertical-fracture flow cell. It is shown that acid can be placed selectively in a vertical fracture by controlling the density and viscosity of the preflush.

2369 **Determination of reservoir properties from backpressure tests with applications to reservoir simulation.** Chain, R.Y.L.; Mountford, C.J.; Raghaven, R.; Thomas, G.W. *J. Pet. Technol.*; **28**: 603-610(May 1976).

From SPE-AIME Northern Plains Section regional meeting; Omaha, NE, USA (15 May 1975).

This paper reports on an investigation of the Odeh—Jones technique for determining values of formation flow capacity and skin factor from backpressure-test data. A three-dimensional reservoir simulator was used to generate the necessary test data under a variety of well and reservoir conditions. Analysis of the data indicates the Odeh—Jones technique yields accurate values of formation flow capacity and skin factor when flowing times between rate changes are small and the reservoir is not severely heterogeneous. An application of the technique to the simulation of a gas storage reservoir is also presented.

2370 **Gamma-ray measuring method for determining an interface between media.** Grodde, K.H. (to Deutsche Texaco Aktiengesellschaft). US Patent 3,959,647. 25 May 1976. Priority date 21 Dec 1973, German, Federal Republic of (F.R. Germany). 4p.

The interface between two fluids such as oil and water in an underground cavern may be detected by placing a gelled substance containing a source of gamma radiation at the interface and detecting the emissions from the gelled substance.

2371 **Critical displacement ratio and its effect on wellbore measurement of residual oil saturation.** Stosur, J.J. (Energy Research and Development Administration, Washington, DC); Taber, J.J. *J. Pet. Technol.*; **28**: 865-868(Aug 1976).

From SPE-AIME 50. annual Fall technical conference and exhibition; Dallas, TX, USA (28 Sep 1975).

A method for estimating the maximum injection rate that can be used without displacing residual oil around the wellbore in logging or other operations is described. By using published information on the critical displacement ratio, the method also can be used to estimate the combinations of oil-water interfacial tension and flooding rates that will be required to displace residual oil near the wellbore or at any point in the reservoir.

PROCESSING

REFER ALSO TO CITATION(S) 3334

2372 (TID/BERC—45) **Petroleum refineries in the United States and Puerto Rico: January 1, 1974.** (Bureau of Mines, Washington, D.C. (USA)). 22 Jul 1974. 21p. TIC.

Data compilations are presented of the crude oil capacity and cracking, reforming, coking, and alkylation capacity of petroleum refineries in the USA and Puerto Rico. (JSR)

PRODUCTS AND BY-PRODUCTS

REFER ALSO TO CITATION(S) 2571

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 4006

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 3833, 3859, 3860, 3864, 3865, 3879

2373 (RLO—2229-T10-1) **Suspended sediments and related limnology of an Alpine lake system. Year end report, June 1, 1975—January 31, 1976.** Alexander, V.; Mellor, J.; Denner, W.W.; Barsdate, R.J. (Alaska Univ., College (USA). Inst. of

Marine Science). 1976. Contract E(45-1)-2229. 41p. Dep. NTIS $3.50.

The rationale for this project centers around the need for a rapid method for assessing impact of construction activity on arctic tundra lakes in terms of change in sediment load regime. In order to evaluate such a method, Peters and Schrader Lakes were selected as a natural laboratory to compare aerial photographic estimates of sediment load with in situ information on transmissivity and gravimetric sediment load determinations. At the same time, the limnological features associated with varying sediment content were evaluated since a distinct gradient in sediment load exists between the heavy glacial input at the southern end of Peters Lake on down through the lake system. The plan for the second year is to extend the work to encompass aerial photography on a variety of lakes along the Trans-Alaska Pipeline road, in order to begin assessing the sediment impact of road construction. Limnological features studied included nutrient distributions, chlorophyll a depth profiles and C-14 primary productivity.

2374 Marine pollution monitoring (petroleum). Proceedings of a symposium and workshop, Gaithersburg, Maryland, May 13—17, 1974. Junghans, R.C. Washington, DC; Department of Commerce (1974). 293p. (NBS-SPEC. PUBL—409; CONF-7405113—). GPO $3.90.

From Proceeding of the marine pollution monitoring (petroleum); Gaithersburg, Maryland, United States of America (USA) (13 May 1974).

These proceedings contain the invited plenary lectures representing pertinent scientific, environmental, and regulatory aspects of petroleum hydrocarbon measurements, the summaries of the contributed papers, dealing with specific scientific developments and recommendations, and the recommendations of the topical discussion groups. Also included is a report of an international workshop which provides specific recommendations for the initiation of a coordinated Pilot Project for marine pollution (petroleum) monitoring. The papers are grouped into six topical sessions, as follows: sampling methods for oil slicks, tar balls, and particulates; sampling and analytical methods for oil in water; standards and intercomparison criteria; analytical methods for oil in marine organisms and sediments; analytical methods for tar balls and particulate matter; and biological assessment.

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 3333, 3345, 3827, 3828, 3833

2375 Clarifications to mandatory petroleum price regulations applicable to domestic crude oil. *Fed. Regist. (Wash., D.C.);* **41**: No. 167, 36172-36186(26 Aug 1976). (10CFR212).

Energy, 10CFR212, Federal Energy Administration—Mandatory petroleum price regulations.

This rulemaking proceeding did not alter any of the major policy decisions already reached, or now under consideration, in the three rulemaking stages to implement the crude oil pricing policies of the Energy Policy and Conservation Act. The purpose of the present rulemaking proceeding has been to resolve as many as possible of a variety of more technical subsidiary issues that have arisen in connection with the implementation of the EPCA. These issues include those related to the definition of "property" and "posted price;" whether a well is properly classified as an "oil well" for purposes of the stripper well lease rule; the partial rescission and modification of Ruling 1975-15, including the issue whether a property's producing patterns have been "significantly altered" for purposes of the enhanced recovery rule applicable to unitized properties (10 CFR 212.75); and whether the certification of domestic crude oil sales presently required in 10 CFR 212.131 is adequate to enable crude oil purchasers to report on the Form FEA-P124-M-O, Domestic Crude Oil Purchaser's Monthly Report, notice of which was also issued on April 13, 1976.

TRANSPORT, PIPELINES, AND HANDLING

REFER ALSO TO CITATION(S) 2373

2376 (TID/BERC—37) Crude-oil and refined-products pipeline mileage in the United States, January 1, 1974. (Bureau of Mines, Washington, D.C. (USA)). 13 Dec 1974. 8p. TIC.

Data compilations are presented for the mileage and pipe size for pipelines for crude oil and refined products. (JSR)

PROPERTIES

REFER ALSO TO CITATION(S) 2568

2377 (PTB-Me—7) Program for the calculation of the density of hydrocarbons and petroleum as a function of the temperature. Mencke, D. (Physikalisch-Technische Bundesanstalt, Braunschweig (Germany, F.R.)). Jun 1975. 108p. (In German). Dep. NTIS (US Sales Only) $5.50.

A computer program RHO 201 in FORTRAN language was developed for reviewing the Petroleum Measurement Tables and estimating the validity range on the basis of the latest measurements. With this program the values of the tables needed such little storage that it could be used in small computers, such as process computers in refineries and petrochemical plants. A relationship was derived between the reduced state variables and the critical density and critical temperature and used to expand the Petroleum Measurement Tables. (JSR)

2378 (ERDA-tr—153) Study of the structure and element composition of group components of petroleum residues using infrared spectroscopy. Gulerman, V.S.; Galiakbarov, M.F.; Kudryashova, E.A.; Zlotskii, S.S. Translated from *Khim. Tekhnol. Topliv Masel;* **17**: No. 3, 55-58(1972). 8p. Dep. NTIS $3.50.

The chemical structure of the components of petroleum residues was studied by means of infrared and ultraviolet spectroscopy. The infrared spectroscopy method was used to study the element chemical composition. Similar components (fractions) of the petroleum residues studies have a practically identical composition and a similar chemical structure.

2379 (ERDA-tr—154) Composition of the fractions of crude oil asphaltenes. Bikbaeva, M.Z.; Vyalkova, L.F.; Ionov, V.I.; Markhasin, I.L.; Umitbaev, R.B. Translated from *Neftepererab. Neftekhim. (Kiev);* No. 5, 14-16(1973). 4p. Dep. NTIS $3.50.

The results from a study on separating asphaltenes with a mixture of solvents, as well as a description of the fractions based on their optical properties, are given. (LK)

NATURAL GAS

REFER ALSO TO CITATION(S) 2355, 2356, 2357

RESERVES

REFER ALSO TO CITATION(S) 2420, 2628

EXPLORATION

2380 (SAND—76-533) Use of potential gradients in massive hydraulic fracture mapping and characterization. Bartel, L.C.; McCann, R.P.; Keck, L.J. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1976. Contract AT(29-1)-789. 19p. (CONF-761008—3). Dep. NTIS $3.50.

From 51. annual meeting of the Society of Petroleum Engineers; New Orleans, Louisiana, United States of America (USA) (3 Oct 1976).

Mapping of massive hydraulic fractures allows for their efficient use to stimulate natural gas production in tight formations. A mapping technique has been used by Sandia Laboratories in conjunction with industry in the Green River Basin at Pinedale, Wyoming and in the Wattenburg field near Denver, Colorado. Comparison of field data to model calculations shows that the electrical potential gradients produced by the direct electrical excitation of the fracture well and fracture fluid can be used to map and characterize massive hydraulic fractures. The direction and any asymmetry of the fracture can be determined.

DRILLING, PRODUCTION, AND PROCESSING

2381 (MERC/TPR—76/2) Lithologic description of core material from Nicholas Combs No. 7239 well, Perry County, Kentucky. Byrer, C.W.; Trumbo, D.B. (Energy Research and Development Administration, Morgantown, W.Va. (USA). Morgantown Energy Research Center). May 1976. 22p. Dep. NTIS $3.50.

The core section which is being studied here is the Devonian Shale. The total thickness of the shale in this region is approxi-

mately 400 feet. The top of the cored section begins at 2369.0 feet and ends at 2708.0 feet. The total length of the core is 339.0 feet. Analysis of this core shows that the top portion (approximately 60 feet) is a medium dark grey shale. A prominent vertical fracture extends almost continuously through this segment. Numerous pyritic nodules and silty stringers are evident throughout. Oblique 60° fractures are found in this interval and throughout the entire core. The middle section contains zones (3 inches to 4 feet in thickness) of darker shale which apparently have higher organic content than the shale described above. This middle segment of the core is approximately 240 feet in length. Many intervals reveal slickensides, many of which are mineral filled. Mineral filled worm burrows are evident along with many carbonaceous fossil fragments. The bottom 40 feet of this core is relatively uniform in composition and appearance. A light medium grey texture is prevalent in this shale segment. There are no vertical fractures, but numerous bedding plane fractures are evident. The bottom segment of this core is characterized by very little pyrite, very few organic zones, very few slickensides, very few worm burrows, and very little carbonaceous fossil material. The γ ray log shows zones of high radioactivity in the shales from 2590 feet to 2665 feet. These zones can usually be correlated over rather wide areas. The core generally shows these to be dark organic rich shale beds.

2382 Turbo-expander applications in natural gas processing. Maddox, R.N.; Bretz, K.E. (Oklahoma State Univ., Stillwater). *J. Pet. Technol.*; **28**: 611-613(May 1976).

From GPA 54. annual convention; Houston, TN, USA (10 Mar 1975).

The advantages of low-temperature, low-pressure separation of natural gas liquids are presented, including a definition of situations in which only a combination of low temperature and low pressure can be applied. The effectiveness of choke and expander processing of a typical natural gas stream are compared. The paper shows that turbo-expander processing is a better method than choke expansion for efficiency of liquids recovery.

PRODUCTS AND BY-PRODUCTS

2383 (COM—75-10332-01) Liquefied natural gas. A literature survey issued quarterly, January—March 1975. Issue No. 75-01. (National Bureau of Standards, Boulder, Colo. (USA). Inst. for Basic Standards). 1975. 15p. NTIS.

For American Gas Association, Arlington, VA.

This bibliography on LNG contains approximately 160 citations covering properties, storage, transport, processing, etc. (LK)

2384 (COM—75-10332-02) Liquefied natural gas. A literature survey issued quarterly, April—June 1975. Issue No. 75-02. (National Bureau of Standards, Boulder, Colo. (USA). Inst. for Basic Standards). 1975. 19p. NTIS.

For American Gas Association, Arlington, VA.

This bibliography on LNG contains approximately 200 citations; areas of coverage include storage, transport, production, properties, and processing. (LK)

2385 (COM—75-10332-03) Liquefied natural gas. A literature survey issued quarterly, July—September 1975. Issue No. 75-03. (National Bureau of Standards, Boulder, Colo. (USA). Inst. for Basic Standards). 1975. 25p. NTIS.

For American Gas Association, Arlington, VA.

This bibliography on LNG contains approximately 335 citations. Subjects covered include storage, transport, production, properties, and processing. (LK)

2386 (COM—75-10332-04) Liquefied natural gas. A literature survey issued quarterly, October—December 1975. Issue No. 75-04. (National Bureau of Standards, Boulder, Colo. (USA). Inst. for Basic Standards). 1975. 18p. NTIS.

For American Gas Association, Arlington, VA.

This bibliography on LNG contains approximately 220 citations and covers areas such as transport, production, storage, properties, and instrumentation. (LK)

ARTIFICIAL STIMULATION, PLOWSHARE, ETC.

REFER ALSO TO CITATION(S) 3791

2387 Explosively created permeability from single charges. McKee, C.R.; Hanson, M.E. (Univ. of California, Livermore). *Soc. Pet. Eng. J.*; **15**: No. 6, 495-501(Dec 1975).

A theoretical expression showing the radial dependence of permeability in geologic media as a function of the distance from the point of detonation has been derived. This relationship shows that created permeability decreases as a function of radius ($1/r^5$ around a spherical blast and $1/r^4$ around a cylindrical shot). Excellent correlation was found when this prediction was compared with permeability measurements made around the site of the Hardhat Nuclear Event fired in granodiorite and a chemical explosive detonated in coal.

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 3345

TRANSPORT, PIPELINES, AND HANDLING

REFER ALSO TO CITATION(S) 2402, 2403, 2404, 2405, 2406, 2407, 3335

2388 Properties of materials for liquefied natural gas tankage. Conference held at Boston, Massachusetts, May 21—22, 1974. Philadelphia; American Society for Testing and Materials (1975). 434p. (ASTM-STP—579; CONF-740549—). $39.75.

From Symposium on properties of materials for liquid natural gas tankage; Boston, Massachusetts, USA (21 May 1974).

Nineteen papers were presented at the symposium. A separate abstract was prepared for each paper. (JRD)

2389 Materials and liquefied natural gas. Weiss, M.J. (Air Products and Chemicals, Inc., Allentown, PA). *Am. Soc. Test. Mater., Spec. Tech. Publ.*; No. 579, 3-9(1975).

From Symposium on properties of materials for liquid natural gas tankage; Boston, Massachusetts, USA (21 May 1974).

See ASTM-STP—579; CONF-740549—.

A general discussion is presented of liquefied natural gas, sources of supply, costs of gas, and a description of the process most commonly used for base-load liquefied natural gas facilities. The cryogenic heat exchanger and materials for pipe, fittings, valves, equipment, and hardware are discussed. Materials for liquid transfer lines, storage tanks, and flare systems, plant capacities, and facility costs are included.

2390 Significance of defects in liquefied natural gas tanks in ships. Tenge, P.; Solli, O.; Forli, O. (Det Norske Veritas, Oslo). *Am. Soc. Test. Mater., Spec. Tech. Publ.*; No. 579, 10-43(1975).

From Symposium on properties of materials for liquid natural gas tankage; Boston, Massachusetts, USA (21 May 1974).

See ASTM-STP—579; CONF-740549—.

The commonly encountered defects in welding of 9 percent nickel steel and aluminum alloy 5083-0 for liquefied natural gas tanks are described, and their significance with respect to fatigue crack propagation and fracture in ship tanks is discussed. Fracture mechanics testing and analysis have been applied. Diagrams describing the growth in depth and length of surface cracks in welded joints as a function of long term distribution of dynamic stresses for North Atlantic service are presented. The possibilities and limitations of the presently used nondestructive testing methods are treated.

2391 Crack growth and fracture of thick 5083-O plate under liquefied natural gas ship spectrum loading. Kelsey, R.A. (Alcoa Labs., Alcoa Center, PA); Wygonik, R.H.; Tenge, P. *Am. Soc. Test. Mater., Spec. Tech. Publ.*; No. 579, 44-79(1975).

From Symposium on properties of materials for liquid natural gas tankage; Boston, Massachusetts, USA (21 May 1974).

See ASTM-STP—579; CONF-740549—.

Data are presented on the growth rate of surface flaws and through cracks in thick aluminum alloy 5083-O plate for spherical liquefied natural gas (LNG) cargo tanks. Tests were made using 135-mm (5.3-in.) thick specimens loaded so as to simulate the bending and membrane stresses in the equatorial ring and 43-mm ($1^3/_4$-in.) thick specimens loaded to simulate the membrane stresses in the bottom region of the tank. The investigation included: (a) determination of crack growth rate under ship spectrum loading; (b) measurement of leak rates through penetrated cracks; and, (c) fracture strength of the cracked specimens. The tests demonstrated that there is a large margin of safety against the occurrence of leaks; but, if leaks should occur, the design requirement of "leak-before-failure" is satisfied. Even after penetration, the growth rate of through cracks is extremely slow. Static failure of specimens containing cracks with lengths six times the thickness occurs by ductile tearing rather than by unstable crack growth. Tests were also made to evaluate the tensile properties and the fracture toughness and fatigue crack growth characteristics of the plate and welds used for the large surface-flawed specimen. The

plain and welded plate had exceptionally high toughness at room temperature, d162°C, and -196°C, as demonstrated by the fact that no rapid crack growth was observed in any of the 178-mm-thick notch bend fracture tests. There was no fracture instability in any of the tests, and all failures occurred by ductile tearing.

2392 Fatigue crack growth rate of thick 5083-O plate at room and low temperatures. Person, N.L.; Wolfer, G.C. (Kaiser Aluminum and Chemical Corp., Pleasanton, CA). *Am. Soc. Test. Mater., Spec. Tech. Publ.;* No. 579, 80-95(1975).

From Symposium on properties of materials for liquid natural gas tankage; Boston, Massachusetts, USA (21 May 1974).

See ASTM-STP—579; CONF-740549—.

Thick aluminum alloy 5083-O has gained wide usage in liquefied natural gas (LNG) tank construction. Fatigue crack growth rate (FCGR) characteristics are described for specimens obtained from 5083-O plate in thickness from about $^1/_2$ to 7.75 in. Data were obtained from crack propagation gages and compared with data obtained by an ultrasonic technique. Crack growth rate was measured at 75 and -320°F. At -320°F, FCGR appeared to be substantially lower than at 75°F in the second stage of growth; however, in the accelerated third stage of growth, the FCGR for the two temperatures were similar. Data show that location of specimen in relation to plate thickness can affect crack growth rate, depending on the crack orientation. From crack propagation gage measurements, it was determined that thickness of compact specimens, per se, (1 to 2 in.) had no effect on growth rate.

2393 Fatigue crack growth and fracture toughness of 5083-O aluminum alloy. Argy, G. (Societe Technigaz, Maurepas, France); Paris, P.C.; Shaw, F. *Am. Soc. Test. Mater., Spec. Tech. Publ.;* No. 579, 96-137(1975).

From Symposium on properties of materials for liquid natural gas tankage; Boston, Massachusetts, USA (21 May 1974).

See ASTM-STP—579; CONF-740549—.

Certain material properties of 5083-O aluminum alloy which would be of interest to designers of liquefied natural gas (LNG) tankage are presented and discussed. Fatigue crack growth rates obtained both from specimens containing a semielliptical surface flaw and from compact tension specimens are given and compared to other published data. Values of K/sub c/ for 2-in.-thick plate obtained from center-cracked specimens at room temperature and from compact tension specimens at both room temperature and -260°F and static and dynamic loading are presented. For the latter specimens, R-curves used in the determination of K/sub c/ values are also given. Finally, K/sub Ic/ values are estimated using the J-integral technique. The application of these data to the design of LNG tankage is discussed, paying particular attention to conditions required to assure "leak before failure" behavior.

2394 Fracture toughness and fatigue properties of 5083-O plate and 5183 welds for liquefied natural gas applications. Kaufman, J.G.; Kelsey, R.A. (Alcoa Labs., Alcoa Center, PA). *Am. Soc. Test. Mater., Spec. Tech. Publ.;* No. 579, 138-158(1975).

From Symposium on properties of materials for liquid natural gas tankage; Boston, Massachusetts, USA (21 May 1974).

See ASTM-STP—579; CONF-740549—.

The results of a number of investigations on the properties of 5083-O plate and weldments of various thicknesses have been summarized. The data show that the tensile properties and toughness of 5083-O plate at room and subzero temperatures remain about constant or decrease modestly with an increase in thickness from 1 to 9 in. and that the properties of 5083-O plate formed into a spherical contour by the Alcoa 570 process are essentially the same as those of as-rolled 5083-O plate. Both strength and toughness are higher at -260 and -320°F than at room temperature. The strength and toughness of 5183 welds at room temperature, -260, and -320°F are equivalent to those of the parent plate. The high toughness of these products at those temperatures has been demonstrated by tests of relatively large-scale specimens, all of which have fractured by ductile tearing; conservative engineering estimates of K/sub Ic/ and K/sub c/ have been made based upon these results and those published in the literature. The fatigue crack propagation characteristics of these materials have been established and found to be largely unaffected by temperature, thickness, orientation, or location in the weld. Crack growth rates are faster in moist air than in dry air.

2395 Strength and fracture of 5083-O aluminum weldments. Zinkham, R.E.; Ashton, R.F. (Reynolds Metals Co., Richmond). *Am. Soc. Test. Mater., Spec. Tech. Publ.;* No. 579, 159-175(1975).

From Symposium on properties of materials for liquid natural gas tankage; Boston, Massachusetts, USA (21 May 1974).

See ASTM-STP—579; CONF-740549—.

The mechanical performance of $1^3/_4$-in. (44 mm) 5083-O weldments was examined at room temperature and at -320°F. The welds were made using 5183 and 5356 electrodes and three variations of the gas metal arc process; these were a twenty-pass vertical procedure, a two-pass high-current flat position method, and a one-pass vertical electrogas technique. It was determined that the tensile and yield strengths of the entire weldments, heat-affected zones and weld metals increased with decreasing test temperature. Both 5356 and 5183 filler alloys produced welds which met the existing codes and specifications; however, 5183 was preferred because it resulted in slight increases in strength with no sacrifice in ductility or toughness. In comparison with multipass welding, the high-current method produced welds with low defect levels and, therefore, higher tensile strengths and elongations. The high-current and electrogas weld yield strengths were respectively less due to coarser microstructures. The notch sensitivity and resistance to a propagating crack were slightly lower for weld metal than for the base plate or heat-affected zone at -320°F. This trend was particularly evident for the high-current welds. However, the toughness of all 5083-O welds was indicated to be high, and structural failures would be unlikely to occur at elastic stresses unless cracks were very large.

2396 Design stresses for aluminum alloy 5083-O and 5183 welds at cryogenic temperatures. Bogardus, K.O.; Malcolm, R.C. (Alcoa Labs., Alcoa Center, PA). *Am. Soc. Test. Mater., Spec. Tech. Publ.;* No. 579, 190-204(1975).

From Symposium on properties of materials for liquid natural gas tankage; Boston, Massachusetts, USA (21 May 1974).

See ASTM-STP—579; CONF-740549—.

Data from more than 300 tension tests made at several laboratories on 5083-O sheet and plate at cryogenic temperatures have been evaluated. Based on these data, minimum, allowable design stresses have been developed for temperatures as low as -320°F for inclusion in Section VIII, Division 1 of the American Society of Mechanical Engineers ASME Boiler and Pressure Vessel Code.

2397 Studies on nine percent nickel steel for liquefied natural gas carriers. Sakai, T. (Nippon Steel Corp., Tokyo); Takashima, H.; Tanaka, K.; Matsumae, H.; Yajima, H. *Am. Soc. Test. Mater., Spec. Tech. Publ.;* No. 579, 205-237(1975).

From Symposium on properties of materials for liquid natural gas tankage; Boston, Massachusetts, USA (21 May 1974).

See ASTM-STP—579; CONF-740549—.

The spherical tanks for the Moss-Rosenberg type of liquefied natural gas (LNG) carriers are to be fabricated from rolled and forged nine percent nickel (9Ni) steels, with the former steel being used as tank shell-plate material and the latter as tank equator-ring material. A series of experimental studies was conducted to evaluate the fatigue strength, resistance to fatigue crack propagation, fracture toughness, etc., of these tank steels having due regards to the "leak-before-failure" premise of the Moss-Rosenberg LNG containment system. Various forms of plain and welded test specimens were prepared from shell-plate and equator-ring materials for fatigue tests; and, the effects of stress ratio and surface finish of reinforcement weld on the tank-steel fatigue strength were closely studied. Wide-plate test specimens were fatigue tested under repeated tensile and bending loads, and configurations of through cracks immediately after penetration and crack propagation rates were examined. Notched plain and welded wide-plate test specimens of different thicknesses were prepared from tank steel plates produced from different heats and submitted for tension tests to determine the critical stress intensity factor (K/sub c/ value) at the cryogenic temperature of LNG. Using data obtained on material properties of the rolled and forged ^{9}Ni steels, the structural safety of the spherical LNG tank was evaluated confirming that the ^{9}Ni steel LNG tank completely satisfied the leak-before-failure criterion.

2398 Fatigue crack growth rate studies of partial thickness cracks in ASTM method A 645-74, five percent nickel steel. McCabe, D.E. (Armco Steel Corp., Middletown, OH); Sarno, D.A.; Feddersen, C.E. *Am. Soc. Test. Mater., Spec. Tech. Publ.;* No. 579, 238-260(1975).

From Symposium on properties of materials for liquid natural gas tankage; Boston, Massachusetts, USA (21 May 1974).

See ASTM-STP—579; CONF-740549—.

Importation of liquefied natural gas (LNG) by ocean-going tankers is one short-term solution to the energy crisis. One of the promising candidate materials for the LNG tankage on these vessels is a specially heat treated 5 percent nickel alloy steel according to ASTM Specification for Pressure Vessel Plates, Five Percent Nickel Alloy Steel, Specially Heat Treated (A 645-74). Fatigue data were developed to determine the growth rates of partial-thickness cracks (PTC) as a function of temperature, stress ratio, and fundamental parameters pertinent to spectrum loading. Constant amplitude PTC growth rate was reduced as the test temperature was lowered, accelerated as the stress ratio was increased, and shown to be approximately equivalent to through-thickness crack

growth rates available in the literature. Results of variable amplitude tests showed a significant crack growth retardation effect. These data plus a typical ship spectrum loading histogram were programmed into a computer to make in-service fatigue life predictions. The performance of this computer program was checked against an actual spectrum loaded specimen.

2399 Low temperature fracture behavior of iron—nickel alloy steels. Tobler, R.L.; Mikesell, R.P.; Durcholz, R.L.; Reed, R.P. (National Bureau of Standards, Boulder, CO). *Am. Soc. Test. Mater., Spec. Tech. Publ.;* No. 579, 261-287(1975).

From Symposium on properties of materials for liquid natural gas tankage; Boston, Massachusetts, USA (21 May 1974).

See ASTM-STP—579; CONF-740549—.

Fracture toughness tests over the interval 298 to 4°K and fatigue crack growth rate tests at 298, 111, and 76°K are reported on selected iron—nickel (Fe—Ni) alloys which are commercially available for potential use in storage or transportation of liquefied natural gas (LNG). These alloys include Fe—6Ni and Fe—5Ni in newly developed three-step heat treatments and Fe—^{9}Ni in the quenched and tempered condition. Linear elastic fracture mechanics parameters (K/sub Q/, K/sub Ic/) and J-integral (J/sub Ic/) test data are presented for 1.25-in.-thick compact specimens. Discussion includes comparisons of fatigue crack growth rate and fracture data between alloys.

2400 Strength and fracture toughness of nickel containing steels. Haynes, A.G. (International Nickel Ltd., Birmingham, Eng.); Firth, K.; Hollox, G.E.; Buchan, J. *Am. Soc. Test. Mater., Spec. Tech. Publ.;* No. 579, 288-323(1975).

From Symposium on properties of materials for liquid natural gas tankage; Boston, Massachusetts, USA (21 May 1974).

See ASTM-STP—579; CONF-740549—.

Having relatively high yield strength at liquefied natural gas (LNG) temperatures, nine percent nickel steel offers scope for some increase in design stresses for LNG structures with attendant economies in cost. Corroborative fracture toughness data are presented for small specimens and wide plate tests that indicate favorable behavior and conditions for high stress designs.

2401 General discussion on the toughness of nine percent nickel steel. Omsen, A. (Uddeholms Aktiebolog, Hagfors, Sweden). *Am. Soc. Test. Mater., Spec. Tech. Publ.;* No. 579, 421-424(1975).

From Symposium on properties of materials for liquid natural gas tankage; Boston, Massachusetts, USA (21 May 1974).

See ASTM-STP—579; CONF-740549—.

Results of treatments on the toughness of nickel steels are summarized. Results show that 9 percent nickel steel (UHB 2N90) plates produced according to ASTM Methods A 353-74 and A 553-72 have an impact transition temperature more than 30°C lower than the operation temperature even when testing the plates in the least ductile direction; the steel is too tough for determining true K/sub Ic/ values in the plate thicknesses used. The properties required by the methods are satisfied. If, by some reason, a higher toughness than required by the codes is wanted, the water quenching treatment is preferred. (JRD)

COMBUSTION

REFER ALSO TO CITATION(S) 2352

STORAGE

REFER ALSO TO CITATION(S) 2388, 2389, 2391, 2398, 2399, 2400

2402 Toughness variations through the thickness of thick 5083-O aluminum alloy plate. Lake, R.L. (Kaiser Aluminum and Chemical Corp., Pleasanton, CA). *Am. Soc. Test. Mater., Spec. Tech. Publ.;* No. 579, 176-189(1975).

From Symposium on properties of materials for liquid natural gas tankage; Boston, Massachusetts, USA (21 May 1974).

See ASTM-STP—579; CONF-740549—.

Dynamic tear tests at the Naval Research Laboratory (NRL), using a series of beam specimens with increasing depth, have shown that the toughness of 3-in.-thick 5083 plate varied from surface to mid-plane. To explore the possible extent of such variation in still thicker plate and provide an economical test for assessing the effect of process variables on toughness, similar specimens were tested under static loading. The data obtained could be interpreted with the aid of the plastic resistance concept used by NRL. It was found that they would also yield approximate values of strain energy release rate at crack initiation (G/sub Ic), thus, linking the dynamic tear test and ratio analysis diagram directly to elastic-plastic fracture mechanics. The test method is much more economical than full plate thickness tests, and the results are believed to be more indicative of the materials' resistance to fracture than small specimen (invalid) K/sub Ic/ values, which are more indicative of material yield strength and the crack length dictated by specimen size, than they are of toughness. Surface layers of one 5083-O plate, 7.75 in. thick (195 mm), were found to be 20 to 30 percent tougher than center layers at room temperature. Toughness of the surface layers improved somewhat as the temperature was lowered to -260°F. However, the improvement of the center layers was more dramatic. At the lower test temperature toughness was essentially uniform throughout the plate thickness.

2403 Newly developed welding material for liquefied natural gas application. Nishi, T.; Saito, S.; Nakano, T.; Horii, Y. (Nippon Steel Corp., Tokyo). *Am. Soc. Test. Mater., Spec. Tech. Publ.;* No. 579, 324-347(1975).

From Symposium on properties of materials for liquid natural gas tankage; Boston, Massachusetts, USA (21 May 1974).

See ASTM-STP—579; CONF-740549—.

The purpose of this study is to put the ^{37}Ni—^{6}Mn—^{16}Cr type weld metal to practical application for the gas metal arc (MIG) welding of ^{9}Ni steel. The effect of molybdenum, tungsten, and nitrogen on the strength and notch toughness of weld metal and the effect of silicon and sulfur on the hot crack sensitivity were examined. Then the joint efficiencies of MIG weldments made with an optimum level of filler wire chemical composition were examined varying heat input of welding and plate thickness. The center-notched wide plate tension test was conducted in order to ascertain the satisfactory performance of this filler wire in comparison with the conventional ^{70}Ni type filler wire. This filler wire is applicable for Ar—Co_2 gas shielded arc welding which produces stable arc and good penetration, thus preventing from occurrence of lack of fusion.

2404 Cryogenic toughness through microstructure control in an iron—nickel—titanium alloy. Jin, S.; Whitaker, B.; Morris, J.W. Jr.; Zackay, V.F. (Univ. of California, Berkeley). *Am. Soc. Test. Mater., Spec. Tech. Publ.;* No. 579, 348-360(1975).

From Symposium on properties of materials for liquid natural gas tankage; Boston, Massachusetts, USA (21 May 1974).

See ASTM-STP—579; CONF-740549—.

The selection of composition and processing of an iron—nickel—titanium (Fe—Ni—Ti) alloy having a favorable combination of strength and toughness at cryogenic temperatures is discussed. Criteria on alloy composition lead to the choice of low interstitial Fe—^{12}Ni—0.25Ti. The alloy has a naturally favorable microstructure, but cryogenic toughness must be imparted through grain refinement. Several alternate procedures are identified; four of these are discussed in detail, along with the resulting tensile properties at 77°K, Charpy impact energies at 77 and 5°K, and behavior in fracture toughness tests at 77°K. Alloys are obtained having yield strengths to 150 ksi with excellent impact toughness to 5°K.

2405 Cryogenic properties of iron—manganese and iron—manganese—chromium alloys. Schanfein, M.J.; Yokota, M.J.; Zackay, V.F.; Parker, E.R.; Morris, J.W. Jr. (Univ. of California, Berkeley). *Am. Soc. Test. Mater., Spec. Tech. Publ.;* No. 579, 361-377(1975).

From Symposium on properties of materials for liquid natural gas tankage; Boston, Massachusetts, USA (21 May 1974).

See ASTM-STP—579; CONF-740549—.

A wide range of microstructures were obtained in iron-manganese alloys by varying the manganese and chromium contents. When a body centered cubic α structure was produced, increasing amounts of manganese were found to be detrimental to low temperature toughness. At manganese levels greater than 12 percent where appreciable amounts of epsilon and γ phases formed, the ductile-brittle transition temperature dropped rapidly. In terms of the epsilon + γ phases present, the ductile-brittle transition temperature decreased at a rate of 1.3°C/ volume percent epsilon + γ. Increasing the epsilon + γ content to achieve good low temperature toughness, however, also caused a decrease in the yield strength. Increases in the yield strength were achieved without appreciable increase in the ductile-brittle transition temperature by greater manganese and chromium additions.

2406 Strain-cycling fatigue behavior of ten structural metals tested in liquid helium, liquid nitrogen, and ambient air. Nachtigall, A.J. (Lewis Research Center, Cleveland). *Am. Soc. Test. Mater., Spec. Tech. Publ.;* No. 579, 378-396(1975).

From Symposium on properties of materials for liquid natural gas tankage; Boston, Massachusetts, USA (21 May 1974).

See ASTM-STP—579; CONF-740549—.

The strain-cycling fatigue behavior of 10 different structural alloys and metals (two aluminum alloys, two titanium alloys, two stainless steels, a maraging steel, a high-nickel alloy, pure nickel, and pure copper) was investigated in liquid helium, liquid nitrogen, and ambient air at room temperature. Cylindrical hourglass-shaped specimens were loaded in compression and tension about zero mean strain to produce the desired strain ranges. Tensile properties were also obtained for each material and environmental temperature so that they could be used with the Manson-Hirschberg method of universal slopes to predict the fatigue behavior at each temperature. At high cyclic fatigue lives, fatigue resistance increased with decreasing temperature for all the materials investigated. At low cyclic fatigue lives, fatigue resistance generally decreased with decreasing temperature for the materials investigated. At low cyclic fatigue lives, fatigue resistance generally decreased with decreasing temperature for the materials investigated. Only for Inconel 718 did the fatigue resistance increase with decreasing temperature over the entire life range investigated. Comparison of experimental fatigue behavior with that predicted by the Manson-Hirschberg method of universal slopes showed that the strain-cycling fatigue behavior of the materials at cryogenic temperatures can be predicted with an accuracy comparable to that achieved in earlier investigations conducted at room temperature. Of the fatigue data obtained at cryogenic temperatures 80 percent were predicted within a life factor of 3.

2407 Low temperature elastic properties of aluminum 5083-O and four ferritic nickel steels. Weston, W.F. (National Bureau of Standards, Boulder, CO); Naimon, E.R.; Ledbetter, H.M. *Am. Soc. Test. Mater., Spec. Tech. Publ.;* No. 579, 397-420(1975).

From Symposium on properties of materials for liquid natural gas tankage; Boston, Massachusetts, USA (21 May 1974).

See ASTM-STP—579; CONF-740549—.

The low-temperature elastic properties have been determined for five commercial alloys that have possible structural applications at cryogenic temperatures. The alloys are 5083-O aluminum and four ferritic steels: 3.5, 5, 6, and 9 percent nickel. An ultrasonic (10 MHz) pulse-superposition method was used to measure longitudinal and transverse wave velocities. Using the velocities and the mass density as input, the following elastic constants were calculated: longitudinal modulus, Young's (tensile) modulus, shear (rigidity) modulus, bulk modulus (reciprocal compressibility), and Poisson's ratio. Measurements were made semicontinuously from 300 to 4°K. The room-temperature composition dependence of iron—nickel alloys is reviewed comprehensively up to 12 percent nickel. Debye temperatures were calculated from the elastic constants. A discussion is given of the temperature dependences of the elastic constants and differential relationships among the elastic constants.

OIL SHALES AND TAR SANDS

2408 Science and technology of oil shale. Yen, T.F. (ed.). Ann Arbor; Ann Arbor Science Publishers Inc. (1976). 232p. $28.50.

The fifteen chapters in this book were abstracted and indexed individually for ERA/EBD. (JGB)

RESERVES AND EXPLORATION

REFER ALSO TO CITATION(S) 2417, 4029

SITE GEOLOGY AND HYDROLOGY

SITE GEOLOGY

REFER ALSO TO CITATION(S) 2418

SITE HYDROLOGY

2409 (TID—27127) Survey of potential methods for resource recovery from black water of the Upper Green River Basin. Phillips, T.E. (Wyoming Univ., Laramie (USA)). May 1976. Contract E(29-2)-3694. 81p. Dep. NTIS $5.00.

Thesis.

Black water is found in the lean oil shales of the Upper Green River Basin of Wyoming. A variety of methods were examined for the separation of organic matter and salts from black water. Black water consists primarily of 5 to 8 percent organic acids and 4 to 6 percent sodium carbonate and bicarbonate dissolved in water. The solution has a pH of 10. Acidifying the black water solution to pH 3 precipitates the organic acids. The black water can be concentrated by evaporation of the water or by natural freezing. Both liquid—liquid extraction of the black water and leaching of the dehydrated black water with a wide range of polar and nonpolar solvents do not appear to be effective methods of separating the organic acids from the salts. Retorting the black water under a carbon monoxide atmosphere converts the black water to a sodium bicarbonate solution and 44 percent of the original organic acids to a benzene soluble oil.

OIL PRODUCTION, RECOVERY, AND REFINING

IN SITU METHODS, TRUE AND MODIFIED

REFER ALSO TO CITATION(S) 2410, 2412, 2416

REFINING

2410 Production of synthetic crude from crude shale oil produced by in situ combustion retorting. Frost, C.M.; Poulson, R.E.; Jensen, H.B. *Am. Chem. Soc., Div. Fuel Chem., Prepr.;* **19**: No. 2, 156-168(1974).

A premium synthetic crude oil was produced by catalytic hydrogenation of an in situ crude shale oil after selection of a suitable catalyst. The processes are described.

PURIFICATION

2411 Comparison of shale gas oil denitrification reactions over Co—Mo and Ni—W catalysts. Silver, H.F.; Wang, N.H.; Jensen, H.B.; Poulson, R.E. *Am. Chem. Soc., Div. Fuel Chem., Prepr.;* **19**: No. 2, 147-155(1974).

Relative to total nitrogen removal, rates of conversion of quinoline-, indole-, amide-type nitrogen in a shale-oil heavy gas oil hydrogenated using three different catalysts were measured.

PROPERTIES AND COMPOSITION

REFER ALSO TO CITATION(S) 2409, 2420

2412 (UCRL—51957(Rev.1)) **Pressure distribution in beds of oil-shale rubble.** Carley, J.F. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 31 Mar 1976. Contract W-7405-Eng-48. 17p. Dep. NTIS $3.50.

The Janssen equation for vertical distribution of pressure in beds of solid particles was applied to beds of broken shale. From a measured angle of repose of sample shale piles of 40°, frictional properties of shale beds were deduced, permitting the constants of the Janssen equation to be computed. Pressure distributions in beds 30-, 61-, and 76-m (100-, 200-, and 250-ft) square and up to 427-m (1400-ft) deep were computed. The main finding was that bottom pressures (P/sub B/) at depths of 152 m (500 ft) and more are only slightly affected by overburden pressure and asymptotically approach values given by P/sub B/ (psi) approximately equal to D (ft) or P/sub B/ (MPa) approximately equal to 0.023D (m) where D is the width of the rubble column. Because of wall friction, these bottom pressures are generally far less, in thick beds, than the hydrostatic equivalent of the weight of shale and overburden. Shale grade (density), rubble porosity, and uncertainties in coefficient of friction have only minor effects on the pressure distributions. Since the pressure exerted by unbroken overburdens may be expected to be small [probably less than 1.38 MPa (200 psi)], pressures are not likely to exceed 2.07 MPa (300 psi) anywhere in the bed. The major uncertainty is the temperature dependence of bed properties. (auth)

2413 Direct determination of organic hydrogen in oil shales by low-temperature ashing. Smith, J.W.; Futa, K. (Laramie Energy Research Center, WY). *Chem. Geol.;* **14**: 31-38(1974).

Direct determination of the organic hydrogen content of oil shales was achieved using low-temperature ashing to separate organic hydrogen from the rock. This organic hydrogen content, particularly useful in characterizing the organic materials in oil shales and other sediments, has been available only by laborious and indirect procedures. Treatment of a sample with the low-temperature asher (LTA) oxidizes organic hydrogen into water which is recovered and weighed. Four oil-shale samples representing the two major deposits of the United States of America were used to demonstrate the method. Directly determined organic hydrogen values compare favorably to the indirect values available on the demonstration samples. Mineral hydrogen contents can also be determined after LTA treatment by analyzing the organic-free

residue. This method should be easily extended from oil shales to other organicsbearing sedimentary rocks.

2414 Pulsed NMR examination of oil shales: estimation of potential oil yields. Miknis, F.P.; Decora, A.W.; Cook, G.L. *Am. Chem. Soc., Div. Fuel Chem., Prepr.;* **19**: No. 2, 86-91(1974).

A rapid method for assaying oil shales based on pulsed nuclear magnetic resonance techniques is discussed. Linear correlations were obtained between NMR measurements and Fischer assay oil yields for 440 samples.

2415 Retorting indexes for oil-shale pyrolyses from ethylene—ethane ratios of product gases. Jacobson, I.A. Jr.; Devora, A.W.; Cook, G.L. *Am. Chem. Soc., Div. Fuel Chem., Prepr.;* **19**: No. 2, 183-191(1974).

A number called retorting index is developed from the relationship of reciprocal temperature versus log [(ethylene)/(ethane)]. The retorting index has the units of temperature. Its magnitude depends on both temperature and residence time for the reactants in the heated zone in oil shale retorting.

2416 Characteristics of synthetic crude from crude shale oil produced by in situ combustion retorting. Poulson, R.E.; Frost, C.M.; Jensen, H.B. *Am. Chem. Soc., Div. Fuel Chem., Prepr.;* **19**: No. 2, 175-182(1974).

The oil was found to be approximately 20 percent aromatic, 6 percent olefinic, and 72 percent paraffinic (including naphthic) hydrocarbons. The 2 percent polar materials present were 55 percent pyrrole- and 45 percent pyridine-type nitrogen compounds.

2417 Permittivity and electrical conductivity of oil shale. Piwinskii, A.J.; Duba, A. (Univ. of California, Livermore). *Int. J. Rock Mech. Min. Sci. Geomech. Abstr.;* **13**: 165-166(1976).

An investigation was made of the electrical conductivity and the real part of the complex permittivity of oil shale. Results are reported of a study on oil shale under ambient conditions prior to, and after, retorting to temperatures of 800°K. The rocks chosen for investigation came from the Anvil Point's Mine, Colorado; these oil shale specimens are from the Parachute Creek member of the Green River formation, Piceance Creek Basin. Data presented indicate that the unretorted sample is a better conductor by as much as an order of magnitude at 10 kHz. Results of the permittivity and conductivity studies indicate that these variables are directly related to the oil content of the shale and may be used to monitor the retorting of oil shale in situ. (MCG)

2418 Concentration and mineralogical residence of elements in rich oil shales of the Green River Formation, Piceance Creek Basin, Colorado, and the Uinta Basin, Utah: A preliminary report. Desborough, G.A.; Pitman, J.K.; Huffman, C. Jr. (Geological Survey, Denver). *Chem. Geol.;* **17**: No. 1, 13-26(Feb 1976).

Ten samples from drill cores of two rich oil-shale beds from the Parachute Creek Member of the Eocene Green River Formation, Piceance Creek Basin, Colorado, and Uinta Basin, Utah, were analyzed for 37 major, minor, and trace elements. For 23 of these elements, prinicpal mineralogical residence is established or suggested. Both raw and ashed shale samples were analyzed by x-ray fluorescence, atomic absorption, optical emission spectroscopy and other methods. Results are tabulated. (JGB)

2419 Direct determination of organic carbon in oil shale. Heistand, R.N.; Humphries, H.B. (Development Engineering, Inc., Rifle, CO). *Anal. Chem.;* **48**: No. 8, 1192-1194(Jul 1976).

A direct determination of organic carbon in oil shale has been developed to replace the normal procedure in which organic carbon is calculated as the difference between the total carbon and the inorganic carbon. The direct determination is obtained by controlled combustion using the Perkin-Elmer Model 240 Elemental Analyzer. Inorganic carbonates are not pyrolyzed when the combustion temperature is lowered to 450 +- 10°C. Precision of the method is +-0.10 percent org. C. The organic carbon data are useful in raw shale characterization, can be related to potential oil yield, and serve as a measure of energy potential, or coke, remaining on the retorted shale.

BY-PRODUCTS

REFER ALSO TO CITATION(S) 2420

FISSION FUELS

RESERVES

REFER ALSO TO CITATION(S) 2443, 2949, 3321

2420 (BM-IC—8700) Uranium from the Chattanooga shale: some problems involved in development. Mutschler, P.H.; Hill, J.J.; Williams, B.B. (Bureau of Mines, Pittsburgh, Pa. (USA). Eastern Field Operation Center-Field and Environmental Activities). 1976. 89p. Bureau of Mines, Washington, DC.

Chattanooga shale was studied to determine the quantity and quality of the uranium resources present and to assess specific environmental effects of mining the shale. Geologic data and chemical analyses, mainly concerning a 12-county area of Tennessee, were compiled from previous published and unpublished reports. Uranium resources in the Gassaway Member of the Chattanooga Shale Formation in this 12-county area were estimated to be between 4.2 and 5.1 million tons, contained in 76 to 91 billion tons of shale. These figures represent inground tonnages and do not allow for mining or processing losses. Depending upon efficiency of mining and processing systems, enough uranium could be available to satisfy a large part of the cumulative domestic and world demand through the year 2000. A model was developed which assesses the total tons or acres of shale to be mined if the Gassaway Member were to satisfy 1 percent of the United States demand for uranium in 1991. This partially demonstrates the environmental impact of mining the shale and is easily factorable to any specified demand.

2421 (INIS-mf—3071) Bibliography: Uranium resources with special reference to Australia. (Institution of Engineers, Sydney (Australia)). 1975. 2p. INIS.

The bibliography is divided into two sections: Part A, uranium resources (general) (29 refs.) and Part B, Australian uranium resources (9 refs.).

2422 Origin of Australian uranium deposits: a universal process that can be applied to deposits in Saskatchewan. Langford, F.F. (Univ. of Saskatchewan, Saskatoon). pp 229-244 of In Fuels: a geological appraisal. Parslow, G.R. (ed.). Regina, Saskatchewan; Saskatchewan Geological Society (1975).

From Symposium on fuels) a geological appraisal; Regina, Saskatchewan, Canada (7 Nov 1974).

In Australia, representatives of three main types of uranium occurrences are present: sedimentary, epigenetic vein, and calcrete (caliche) deposits. Calcrete deposits are particularly important because it appears probable that the surficial processes which formed them are similar to those which gave rise to the other types, thus providing a unifying theory of uranium deposition. The calcrete deposits of Western Australia are fairly typical calcretes (caliches) of surficial origin. Uranium occurs as carnotite in fractures within calcite. The uranium is derived from the weathering and erosion of the surrounding crystalline Precambrian Shield. In the Northern Territories, epigenetic vein deposits display such a consistent relationship to major unconformities that the latter must have played a marked role during the genesis of the veins. Deposits occur near granite-gneiss complexes, but evidence for a hydrothermal connection is lacking. A surficial origin explains contradictions produced by the hydrothermal concepts. Similarly in Northern Saskatchewan the epigenetic uranium deposits occur at a major unconformity. Although the source of the uranium is popularly ascribed to the nearby country rock, the epigenetic deposits formed much too late to partake of any hydrothermal fluids produced during granitization, and country rocks do not display post-consolidation leaching. Both the nature of mineralization and timing of repeated episodes are inconsistent with a hydrothermal origin. Formation of the vein deposits by surficial processes negates these problems, and indeed, at Beaverlodge, the processes may actually have been recorded in operation.

2423 Annotated bibliography of Grants uranium region, New Mexico, 1950 to 1972. Schilling, F.A. Jr. Socorro, NM; New Mexico Bureau of Mines and Mineral Resources (1975). 69p. $4.00.

A list of 319 citations with annotations of papers pretaining to the geology of the Grants uranium region of New Mexico is given. The citations are listed in alphabetical order. A subject index is included. This bibliography treats material published during the period 1950 to 1972. (BLM)

2424 Uranium resources to meet long-term uranium requirements. Searl, M.F. *Arch. Energiewirtsch.;* **29**: No. 10, 967-977(Oct 1975). (In German).

2 figs.; 6 tabs. Excerpt from Combustion (May 1975) p. 13.

The uranium reserves and the future uranium demand of the USA are estimated. The basis for the estimation of the uranium reserves is provided by AEC statistics and geological data. The uranium demand assessment is based on the service life of all PWR and BWR reactors built so far in the U.S.A.

2425 Supply of enriched uranium for the countries of the Common Market 1974. *Atomwirtsch., Atomtech.;* **20**: No. 12, 631-632(Dec 1975). (In German).

2 tabs. Short communication only.

2426 How much uranium. Kenward, M. *New Sci.;* **69**: No. 993, 686-687(25 Mar 1976).

Comment is made on the latest of a series of reports on world uranium resources from the OECD's Nuclear Energy Agency and the UN's International Atomic Energy Agency (Uranium resources, production and demand (including other nuclear fuel cycle data), published by the Organisation for Economic Cooperation and Development, Paris). The report categories uranium reserves by their recovery cost and looks at power demand and the whole of the nuclear fuel cycle, including uranium enrichment and spent fuel reprocessing. The effect that fluctuations in uranium prices have had on exploration for new uranium resources is considered. It is stated that increased exploration is essential considering the long lead times involved but that thanks to today's higher prices there are distinct signs that prospecting activities are increasing again.

2427 Natural chain reaction in the Oklo mine in Gabon. Burjan, V. *Jad. Energ.;* **22**: No. 4, 148-149(Apr 1976). (In Czech).

An isotopic analysis of a sample of uranium ore from the Oklo mine in Gabon showed a significantly reduced content of ^{235}U (down to 0.296% ^{235}U). The isotopic composition of neodymium (shown), lead, rubidium, ruthenium, strontium, krypton, and xenon proved that a chain reaction took place in the ore deposit approximately 1,800 million years ago. The reaction proceeded for about 10 to 70 thousand years. About 200 kg of ^{235}U has undergone fission and the burn-up amounted to 25,000 MWd/t.

EXPLORATION

REFER ALSO TO CITATION(S) 2359, 3321

2428 Uranium exploration in Canada. Merlin, H.B. (Dep of Energy, Mines and Resour, Ottawa, Ont). *West. Miner;* **48**: No. 2, 23-24, 26, 28(Feb 1975).

Paper reviews the historical development of exploration for and mining of uranium ores since WWII which have reached their peak in 1959 of 16,000 t of U_3O_8. Over abundance of produced uranium that lasted till late 1973 has caused many mines and treatment plants to close. The 1973/4 dramatic change has been brought about by the acceleration of nuclear energy programs and uranium purchases by utilities, together with unexpected curtailment of marketing activities by several, international uranium producers. Present exploratory activities in Canada both with government support and by private sector are described.

2429 (DPST—75-138-2) **Savannah River Laboratory quarterly report, April—June 1975. Hydrogeochemical and stream sediment reconnaissance, eastern United States.** (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). 1975. Contract AT(07-2)-1. 31p. Dep. NTIS $4.00.

The development of field sampling and assay equipment continued with the fabrication of samplers and water filtration systems. Orientation studies are in progress in Texas, Georgia, and North and South Carolina. The neutron activation facility and the ^{252}Cf activation facility are described. Formats for field and laboratory data sheets were defined and definition of the data file is underway. (JSR)

2430 (DPST—76-138-2) **National Uranium Resource Evaluation Program. Hydrogeochemical and stream sediment reconnaissance, eastern United States. Savannah River Laboratory quarterly report, April—June 1976.** (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). 1976. Contract AT(07-2)-1. 103p. (GJBX—27-76). Dep. NTIS $5.50.

Evaluation of seasonal effects on the hydrogeochemistry of uranium was continued in Oconee County, South Carolina, and the Brush Creek area, North Carolina. A contract was written for a seasonal sampling program in Maine. Sampling began in April and will continue through the first quarter of FY 1977. Procedures manuals were written and training sessions for subcontractors were held. Reconnaissance sampling is in progress. Three subcontractors will collect 10,800 samples from over 50,000 square miles of the southern Appalachians. A contract was written for orientation studies in New Hampshire and Maine. The well sampling feasibility study in western New York State was completed. Evaluation of orientation data continues, including Williamsport area, Pennsylvania; North Harper Creek, Cleveland and Moore County areas, North Carolina; and east central Alabama. Preliminary supplementary elemental data from both the Cleveland and North Harper Creek study areas show that cobalt correlates strongly with uranium. A priority order was established for sampling 25 eastern states. Approximately 1400 additional samples and standards were analyzed for uranium. Over 2800 irradiation capsules have been processed to date. The SRL-NURE data management system was modified to allow processing of orientation and reconnaissance data as independent files. A sample inventory system is being developed to maintain information for all samples and associated forms. Programs were written to generate geochemical symbols on computer-produced microfiche and to calculate and plot cumulative frequency distributions. A simplified field form designed for reconnaissance sampling was printed and successfully field-tested.

2431 (DPST—76-141-2) **Savannah River Laboratory hydrogeochemical and stream sediment reconnaissance. Raw data release II. Orientation studies in Alabama. National Uranium Resource Evaluation Program.** Price, V.; Ferguson, R.B. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). Jul 1976. Contract AT(07-2)-1. 86p. (GJBX—46-76). Dep. NTIS $5.00.

Raw data for two orientation studies in the Alabama Valley and Ridge, and Upper Coastal Plain are presented. These studies were conducted in cooperation with the Geological Survey of Alabama, Tuscaloosa, Alabama. (LK)

2432 (GSCan-P—75-26, pp 49-71) **Federal-provincial uranium reconaissance program.** Darnley, A.G.; Cameron, E.M.; Richardson, K.A. 1975.

From Prospectors and Developers Association 43. annual convention; Toronto, Ontario, Canada (11 Mar 1975).

2 bibliographies on gamma spectrometry and regional geochemistry.

In Uranium exploration '75.

The program described will involve high sensitivity airborne gamma-ray spectrometry over areas of low relief and some outcrop, required geochemistry in mountainous terrain and in areas with extensive overburden, and special emphasis on hydrogeochemistry in flat-lying sedimentary basins.

2433 (GSCan-P—75-26, pp 33-47) **Geochemistry applied to uranium exploration.** Dyck, W. 1975.

From Prospectors and Developers Association 43. annual convention; Toronto, Ontario, Canada (11 Mar 1975).

59 refs.

In Uranium exploration '75.

The elements of the ^{238}U decay series of interest in geochemical exploration are uranium, radium, radon, and helium. Each element has specific radiochemical and/or geochemical properties which make it a useful tracer for uranium ore deposits.

2434 (GSCan-P—75-26, pp 13-20) **New sources of uranium: types of uranium deposits presently unknown in Canada.** Ruzicka, V. 1975.

From Prospectors and Developers Association 43. annual convention; Toronto, Ontario, Canada (11 Mar 1975).

In Uranium exploration '75.

Most of the main genetic types of uranium deposits occur in Canada. They contain a significant portion of the world's uranium resources. However, there are other economically important types of uranium deposits that to date have not been discovered in this country. As there is no fundamental reason why they could not be present, geologists working in Canada need to be aware of their characteristics so that they are not overlooked in future exploration programs.

2435 (K-TL—602) **National Uranium Resource Evaluation Program. Hydrogeochemical and stream sediment pilot survey of Llano area, Texas.** Nichols, C.E.; Kane, V.E.; Minkin, S.C.; Cagle, G.W. (Oak Ridge Gaseous Diffusion Plant, Tenn. (USA)). 30 Jun 1976. Contract W-7405-Eng-26. 104p. (GJBX—36(76)). Dep. NTIS $5.50.

A pilot geochemical survey of the Llano, Texas, area was conducted during February and March 1976. The purpose of this work was to prepare for a subsequent reconnaissance geochemical survey of uranium in Central Texas. Stream sediment, stream water, well water, and plant ash from five geologic areas were analyzed in the laboratory for approximately 25 parameters. Examples of anomalous values in stream sediment and stream water indicate the usefulness of both sample types in identifying anomalies at a regional reconnaissance-scale station spacing of approximately

5 km (3 mi). Groundwater samples, which generally best indicate the geochemistry of formations at depth in a survey of this type, represent another important tool in detecting uranium mineralization. Anomalies in San Saba County are associated with the Marble Falls-Smithwich Formations and the Strawn Series (Pennsylvanian), the Houy Formation (Devonian and lower Mississippian), and the Hickory Sandstone Member of the Riley Formation (Cambrian). In Burnet County anomalous values are due to the influence of the Valley Spring Formation (Precambrian); and in Blanco County anomalies are found associated with the Riley Formation (Cambrian).

2436 (STI/DOC—10/174) **Radiometric reporting methods and calibration in uranium exploration. Technical reports series.** (International Atomic Energy Agency, Vienna (Austria)). 1976. 64p. IAEA $4.00.

The following topics are discussed: field radiometric measurements and their application, scientific background, present reporting methods, recommended units of measurement, calibration system, and calibration systems for total count surveys and for gamma-ray spectrometric surveys. (LK)

2437 (TID—27135) **Investigation of Alaska's uranium potential. Special report 12.** Eakins, G.R.; Forbes, R.B. (Alaska State Dept. of Natural Resources, College (USA). Div. of Geological and Geophysical Surveys). 1976. Contract AT(05-1)-1627. vp. Alaska Division of Geological and Geophysical Surveys, P.O. Box 80007, College, Alaska 99701 $10.00.

Of the various geographical regions in Alaska that were examined in an exhaustive literary search for the possibility of uranium, either vein-type or sedimentary, six offer encouragement: the Copper River Basin, the alkaline intrusive belt of west-central Alaska and Selawik Basin area, the Seward Peninsula, the Susitna Lowland, the coal-bearing basins of the north flank of the Alaska Range, the Precambrian gneisses of the USGS 1:250,000 Goodnews quadrangle, and southeastern Alaska, which had the only operating uranium mine in the state. Other areas that may be favorable for the presence of uranium include the Yukon Flats area, the Cook Inlet Basin, and the Galena Basin.

2438 **A method and device for determining the potassium, uranium and thorium content of sub-soil formations.** Chevallier, P.; Seeman, B. (to Societe de Prospection Electrique Schlumberger, 75 - Paris (France)). French Patent 2245962/A/. 1 Oct 1973. 16p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France).

A method is described for determining the contents of a sub-soil formation in potassium, in elements of the uranium group and in elements of the thorium group, respectively, through the analysis of the output pulse spectrum of a detector adapted to sense the gamma radiations emitted by said formation. The method consists in measuring the couting rates of those pulses with amplitudes situated within three windows containing peaks corresponding to radiating energies of 1.46-1.76 and 2.62 MeV, respectively. These three windows span nearly the whole spectrum portion containing the above peaks in substantially continuous fashion and each of the three contents is obtained from the three measured counting rates. By means of these contents, it is possible to ascertain the nature and even the composition of the sub-soil formation.

2439 **Carswell circular structure and Cluff Lake uranium orebodies.** pp 47-61 of In Fuels: a geological appraisal. Parslow, G.R. (ed.). Regina, Saskatchewan; Saskatchewan Geological Society (1975).

From Symposium on fuels) a geological appraisal; Regina, Saskatchewan, Canada (7 Nov 1974).

The results of exploration work for the period 1967-74 are discussed. Subsequent to the detection of radiometric anomalies by an airborne survey over the Carswell concentric structure, several trains of pitchblende bearing boulders were encountered during the ground followup work. Delineation of the Cluff Lake pitchblende-uraninite deposits requires the reconstruction of a complex tectonic history. Although only incompletely interpreted at present the following observations can be made: (1) most productive zones are located in the vicinity of flat-lying, thrust faults; (2) the thrusting is due to a centrifugal movement of basement slabs over the younger Athabasca formation. At present, two controls are used as a guide in exploration: the type of structure and the proximity of the basement/cover interface. Mineralization occurs in both the retrogressively metamorphosed basement and the lower part of the sedimentary pile. U grade and mineralogy vary widely from high-grade selenide bearing ore to low grade pitchblende with associated sulphides. Tentative conclusions regarding the origin of the ore indicate a polyphase evolution with the final, and most significant, concentration of ore probably occurring after the formation of the plug-like structure.

2440 **In-situ assaying for uranium in rock formations and method of undirectly monitoring the output of a pulsed neutron source.** Givens, W.W.; Caldwell, R.L.; Mills, W.R. Jr. (to Mobil Oil Corp., New York (USA)). Australian Patent 463611/B/. 15 Jul 1975. 18p.

Filed 1 Jun 1972, publ. 6 Dec 1973, copies available from the Commissioner of Patents, Canberra.

A description is given of a method of assaying for uranium in the formations traversed by a borehole, which comprises: 1) locating a pulsed neutron source and a neutron detector in a borehole at the level of a formation of interest suspected of containing uranium; 2) operating the neutron source cyclically with the time between each neutron burst being sufficient to allow neutrons from the source to disappear but being long enough to allow the delayed neutrons resulting from the neutron fission of uranium to appear at the detector; 3) detecting neutrons with the detector, as a result of the irradiation of the formations with the neutrons from the source, and obtaining measurements of the quantity of neutrons detected between neutron bursts only at a time period when neutrons from the source have disappeared but, while delayed fission neutrons from uranium may be emitted.

2441 **Rapid determination of uranium in ores by means of a carbon paste electrode.** Gaillochet, P. (Compagnie de Produits Chimiques et Electrometallurgiques Pechiney-Ugine Kuhlmann, 75 - Paris (France)); Bauer, D.; Hennion, M.C. (Ecole Superieure de Physique et Chimie Industrielles, 75 - Paris (France). Lab. de Chimie Analytique). *Analusis;* 3: No. 9, 513-516(Nov 1975). (In French).

Electrochemical determination of uranium in ores can be carried out by means of a carbon paste electrode (graphite-aqueous ammonium fluoride-ore). On the voltametric curves uranium shows typical anodic and cathodic peaks the heights of which are proportional to the uranium content of the ore. Ores from different origins and with uranium contents varying from 0.1 to 1.7% have been tested. This method gives an indication of the proportion of U(IV) and U(VI) in the ore.

2442 **Radioactive heat production in rocks and its relation to other petrophysical parameters.** Rybach, L. (Eidgenoessische Technische Hochschule, Zurich (Switzerland)). *Pure Appl. Geophys.;* **114**: No. 2, 309-317(1976).

From Colloquium on petrophysical properties of rocks; Aarhus, Denmark (29 Oct 1974).

Radioactive heat production A is a scalar and isotropic petrophysical property independent of in situ temperature and pressure. Its value is usually expressed in HGU units (1 HGU = 10^{-13} cal/cm^3 sec) and depends on the amounts of uranium, thorium and potassium. A varies with rock type over several orders of magnitude and reflects the geochemical conditions during rock formation (magmatic differentiation, sedimentation or metamorphism). In order to assign realistic thermal parameters to deeper-seated rocks correlations with seismic velocity (which can be determined from the surface) have been looked for. In the range characteristic for crystalline rocks of the crust (5-8 km/sec) A is strongly correlated with density and compressional wave velocity vsub(p): A decreases with increasing vsub(p) or rho. From this relationship it is now possible to estimate heat production values for any particular layer of a crustal section from measured seismic velocities. Contrary to earlier belief there is, as shown by experimental determinations, no correlation between heat production A and thermal conductivity K in igneous and metamorphic rocks. In sediments however, especially in sand/shale sequences, a correlation between K and A is most likely: increasing clay mineral content, characterized by increasing A, causes the decrease of K in these rocks.

MINING

REFER ALSO TO CITATION(S) 2545, 3321, 3814

2443 **Geology and history of Eldorado's Hab mine, Beaverlodge District, Saskatchewan.** Olsson, W. (Eldorado Nuclear Ltd., Saskatchewan). pp 149-178 of In Fuels: a geological appraisal. Parslow, G.R. (ed.). Regina, Saskatchewan; Saskatchewan Geological Society (1975).

From Symposium on fuels) a geological appraisal; Regina, Saskatchewan, Canada (7 Nov 1974).

The Hab mine, located seven miles northeast of Uranium City, lies within the regional metamorphosed and granitized polydeformational rocks of the Tazin Group in the Churchill structural province of the Canadian Shield. Originally prospected and staked in 1948 and subsequently explored in detail, the property, in 1970, became the first new producer of uranium in the

Athabasca region for over ten years. Production is scheduled to be completed in the fall of 1974. This low tonnage, high-grade deposit contains two distinctly different types of ore bodies known as the 38 and 39 zones. The former is a stockwork-breccia type uranium deposit occurring in a red, granitic rock and the latter consists of discontinuous pitchblende veins associated with near vertical faults cutting a mylonitic quartz-mica schist. The mineralization in both ore bodies was highly erratic; ore grades were related to depth, and all major uranium mineralization terminated within a depth of 500 feet below the adit level. Considerable unsuccessful exploration was performed laterally and with depth in an attempt to test for extensions of the ore-bearing structures and to explore for parallel structures. Upon completion of mining the total estimated production will be approximately 250,000 tons averaging in excess of 8 pounds per ton of U_3O_8, which would classify the deposit as the third largest in the Beaverlodge area behind the Eldorado Fay-Verna mine complex and the Gunnar mine.

FEED PROCESSING

REFER ALSO TO CITATION(S) 2544

2444 (GSCan-P—74-35) **Extraction of uranium from aqueous solutions by coals of different rank and petrographic composition.** Cameron, A.R.; Leclair, G. (Geological Survey of Canada, Ottawa, Ontario). 1975. 10p. INIS.

13 refs.

A series of laboratory tests was run to test the uranium extraction capabilities of coals of different rank and petrographic composition. Coals of five different ranks, ranging from lignite to low volatile bituminous, were used and each rank was represented by a vitrinite-rich and fusinite-rich fraction. A sample of coke made from low volatile coal also was tested. The samples were crushed and the -70 to +140 mesh fractions were immersed in solutions of known uranium content for a period of 32 days. Periodic checks were made to measure degree of uranium removal and pH. The coke, lignite and subbituminous samples were the most effective in removing uranium from solution. The fusinite-rich samples were better in this regard than were the vitrinite-rich samples, especially from the higher rank coals. However, this influence of rank and petrographic composition on uranium removal is closely tied to the acidity of the immersing solutions; mixtures with lower pH values removed less uranium from solution than did those which were more alkaline.

2445 **Electrolytic precipitation of ammonium diuranate.** Bryson, A.W. *J. S. Afr. Inst. Min. Metall.*; **76**: No. 2, 13-15(Sep 1975).

An electrolytic process for the treatment of uranium ores is proposed. The ore is oxidized and leached in the anode compartment, while the uranium in the form of ammonium diuranate is precipitated in the cathode compartment. Conditions for the precipitation of the diuranate are described.

2446 **Processing of uranium hexafluoride including absorption of uranium hexafluoride in aqueous aluminum nitrate.** Lillyman, E.; Mascall, F.C.; Mathers, G. (to United Kingdom Atomic Energy Authority). US Patent 3,928,538. 23 Dec 1975. Filed date 29 Oct 1973. 2p.

A process is described in which uranium hexafluoride enriched in U235 is converted to an aqueous uranyl nitrate solution (for subsequent production of oxide). Uranium hexafluoride vapour is absorbed in aqueous aluminium nitrate solution which is then contacted with an organic solvent for extracting uranium and the solvent is washed with dilute nitric acid. 2 Claims, 1 Drawing Figure.

ENRICHMENT

2447 (RED—76-110) **Report of the Comptroller General of the United States. Comments on selected aspects of the Administration's proposal for government assistance to private uranium enrichment groups.** (General Accounting Office, Washington, D.C. (USA)). 1976. 38p. General Accounting Office, Washington, DC.

This report presents GAO's views on matters raised by the Vice Chairman, Joint Committee on Atomic Energy, related to the private ownership of uranium enrichment and reemphasizes GAO's belief that the Government should add on to one of its existing enrichment plants to provide the next increment of enrichment capacity.

GASEOUS DIFFUSION

REFER ALSO TO CITATION(S) 3771

2448 **French program on U enrichment.** Coates, J. (CEA, 75 - Paris (France)). *Rev. Gen. Nucl.*; **1**: No. 4, 265-267(Sep 1975). (In French).

The requirements of the French electronuclear program in enriched uranium and the supplies provided for between now and 1990 are estimated. The three projects of gaseous diffusion plants in preparation or development (Eurodif, Coredif, and Canadif) are described. The research programs on the different isotope separation processes are discussed: gaseous diffusion, centrifugation and also other processes representing a potential interest.

CENTRIFUGATION

2449 **Separating system for uranium isotopes etc.** (to ETA-Corp. G.m.b.H., Hamburg (F.R. Germany)). German(FRG) Patent 2150181/A/. 15 May 1975. 5p. (In German).

1 fig.

The gas introduction pipe in the rotor of a uranium isotope separation process is developed in the form of a Laval, Venturi or Oswatitsch nozzle. The nozzle extends radially from the axial introduction pipe into about the middle third of the rotor space. The rotor and the introduction pipes have contrary directions of rotation. The flow ratios in the rotor can thus be influenced, and oscillations of the system can also be reduced by interference.

2450 **System for the separation of isotopes by centrifugal forces.** van Oordt, H.; van der Adriaan, J.; Hashmi, M. (to Max-Planck-Gesellschaft zur Foerderung der Wissenschaften e.V., Goettingen (F.R. Germany)). German(FRG) Patent 2037030/C/. 7 Aug 1975. 4p. (In German).

2 figs.

Uranium, alkali metal, or alkaline earth metal isotopes are separated using centrifugal forces. A plasma with ions of these isotopes is rotated around an axis in a vacuum chamber. The rotation is induced by a radial electric field and an axial magnetic field between 2 and 8 kg. The enriched heavy components are removed through a peripheric outlet the diameter of which is more than twice the radius of gyration of the ions. The axis holds a W, Re, Ta, or C electrode which emits electrons when heated up to, e.g., 2,500 K. These electrons ionize the isotopes by contact ionization. An atomic beam of the isotopes emerging from an evaporator is directed towards the electrode. Due to the selection of the optimum density profile of the atomic beam and the optimum temperature distribution at the surface of the electrode, a quiet and stable plasma with high rotational speeds is achieved.

2451 **Isotope separation by centrifuge methods.** Los, J.; Kistemaker, J. (Stichting voor Fundamenteel Onderzoek der Materie, Amsterdam (Netherlands). Instituut voor Atoom en Molecuulfysica). *Ned. Tijdschr. Natuurkd.*; **42**: No. 5, 51-54(20 Mar 1976). (In Dutch).

The basic equations for isotope separation are given in terms of molar fractions. Technical design equations are developed for an isolated centrifuge in terms of pressure, radius, rotation speed, mass difference, absolute temperature, etc. An indication is given of optimisation methods for cascades of centrifuges, and estimates of outputs of enriched uranium from multiple plants are given with special reference to the installation at Almelo, Holland.

LASER EXCITATION

2452 (LA-UR—76-499) **Laser chemistry and the nuclear fuel cycle.** Jensen, R.J. (Los Alamos Scientific Lab., N.Mex. (USA)). 1976. Contract W-7405-ENG-36. 9p. (CONF-760505—1). Dep. NTIS $3.50.

From NSF workshop on the laser revolution in energy-related chemistry; Cambridge, Massachusetts, United States of America (USA) (9 May 1976).

The application of lasers to isotope enrichment and to the study and process of photochemical improvements to the fuel recycle process is discussed. Laser power and laser specifications for these areas are indicated. (JSR)

2453 (LA-UR—76-1647) **Lasers for isotope separation.** O'Hair, E.A.; Piltch, M.S. (Los Alamos Scientific Lab., N.Mex. (USA)). 1976. Contract W-7405-ENG-36. 8p. (CONF-760832—11). Dep. NTIS $3.50.

From 20. annual SPIE technical symposium; San Diego, California, United States of America (USA) (23 Aug 1976).

The Los Alamos Scientific Laboratory is conducting research on uranium enrichment. All processes being studied employ uranium molecules and use lasers to provide isotopic selectivity and enrichment. There are four well-defined infrared frequencies and two ultraviolet frequency bands of interest. The infrared frequencies are outside the range of the available lasers and an extensive research and development activity is currently underway. Lasers are available in the uv bands, however, much development

work remains. The specification for the commercial uranium enrichment plant lasers will depend upon the results of the current enrichment experiments, the laser capital cost, reliability, and maintenance cost. For the processes under investigation there are specific photon requirements but latitude in how these requirements can be met. The final laser selections for the pilot plant need not be made until the mid-1980's. Between now and that time as extensive as possible a research and development effort will be maintained.

2454 Laser spectroscopy. Proceedings of the second international conference held at Megeve, France, June 23—27, 1975. Haroche, S.; Pebay-Peyroula, J.C.; Haensch, T.W.; Harris, S.E. (eds.). New York; Springer-Verlag (1975). 478p. (CONF-7506103—).

From Conference on laser spectroscopy; Megeve, France (23 Jun 1975).

Individual papers were abstracted and indexed separately. (LK)

2455 Separation of uranium isotopes by selective photoionization. Snavely, B.B.; Solarz, R.W.; Tuccio, S.A. pp 268-274 of In Laser spectroscopy. Haroche, S.; Pebay-Peyroula, J.C.; Haensch, T.W.; Harris, S.E. (eds.). New York; Springer-Verlag (1975).

From Conference on laser spectroscopy; Megeve, France (23 Jun 1975).

See CONF-7506103—.

Recent results of experiments on laser photoseparation of uranium isotopes are reported. (LK)

2456 Method of and apparatus for separating isotopes. Levy, R.H.; Janes, G.S. (to Jersey Nuclear-Avco Isotopes, Inc., Bellevue, Wash. (USA)). Australian Patent 464698/B/. 20 Aug 1975. 41p.p.

Filed 23 Mar 1971, publ. 28 Sep 1972, priority USA 25 Mar 1970 (25605), copies available from the Commissioner of Patents, Canberra.

A method is described for separating a first isotope from a second isotope of a material, which comprises the steps of: 1) producing a beam of a vapor comprising ionized atoms of the first isotope and non-ionized atoms of the second isotope, 2) impressing a magnetic field and an electric current upon the beam, in a manner to thereby accelerate the ionized atoms out of the beam in a direction at an angle to the direction of motion. The beam of vapor comprising the ionized atoms and non-ionized atoms is produced by first producing from the material an initial beam of vapor having atoms of the isotopes, exposing the initial beam of vapor to monochromatic radiation to excite atoms of the first isotope without substantially exciting atoms of the second isotope; and exposing the initial beam of vapor to monochromatic radiation to ionize excited atoms of the first isotope without substantially ionizing atoms of the second isotope.

FUELS PRODUCTION AND PROPERTIES

REFER ALSO TO CITATION(S) 3458, 3486, 3525, 3526, 3534, 3537, 3542, 3543, 3548, 3549

2457 (ORNL/TM—5579) **In-line monitoring of effluents from HTGR fuel particle preparation processes using a time-of-flight mass spectrometer.** Lee, D.A.; Costanzo, D.A.; Stinton, D.P.; Carpenter, J.A.; Rainey, W.T. Jr.; Canada, D.C.; Carter, J.A. (Oak Ridge National Lab., Tenn. (USA)). Aug 1976. Contract W-7405-eng-26. 27p. Dep. NTIS $4.00.

The carbonization, conversion, and coating processes in the manufacture of HTGR fuel particles have been studied with the use of a time-of-flight mass spectrometer. Non-condensable effluents from these fluidized-bed processes have been monitored continuously from the beginning to the end of the process. The processes which have been monitored are these: uranium-loaded ion exchange resin carbonization, the carbothermic reduction of UO_2 to UC_2, buffer and low temperature isotropic pyrocarbon coatings of fuel kernels, SiC coating of the kernels, and high-temperature particle annealing. Changes in concentrations of significant molecules with time and temperature have been useful in the interpretation of reaction mechanisms and optimization of process procedures.

2458 Apparatus for separating and continuously recovering a particulate material carried by a gas stream. Becker, W.R.; Dada, A.G.; Dehollander, W.R.; Sloat, R.J. (to General Electric Co., Schenectady, N.Y. (USA)). French Patent 2243012/A/. 11 Sep 1974. 24p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France); priority claim: 12 Sept. 1973, USA.

Description is given of an apparatus adapted to separate and recover a particulate material carried by hot corrosive gases. The apparatus comprises a flow-channel connected to a gas stream source carrying a particulate material, a first and second tubes connected to said flow-channel, filtrating devices, recovery containers and flow-restricting valves. This can be applied to the recovery of uranium oxides generated by flame reactions.

2459 Some aspects of the vaporization behavior of the U—Pu—C system. Tetenbaum, M.; Sheth, A. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.*; **23**: 129-130(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2460 Densities of liquid carbides and nitrides of uranium and plutonium. Sheth, A.; Leibowitz, L.; Winslow, G. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.*; **23**: 130-131(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2461 Total pressures of uranium- and plutonium-bearing species above the U—Pu—O system. Tetenbaum, M. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.*; **23**: 131-132(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2462 Graphite matrix fuels for pulsed reactors. Marion, R.H.; Karnes, C.H.; Morris, F.M.; Reuscher, J.A. (Sandia Labs., Albuquerque, NM). *Trans. Am. Nucl. Soc.*; **23**: 132(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2463 Development and testing of BeO—UO_2 fuel for pulse reactor applications. Pickard, P.S. (Sandia Labs., Albuquerque, NM); Sasmor, D.J.; Coats, R.L.; Holt, J.B. *Trans. Am. Nucl. Soc.*; **23**: 132-133(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

SPENT FUELS REPROCESSING

REFER ALSO TO CITATION(S) 2487, 2499, 2506, 2543, 2950, 3322, 3571, 3575, 3578, 3587, 3608

2464 (AED-CONF—75-404-024) **Radiochemical investigation on the distribution of ^{129}I and ^{3}H in irradiated nuclear fuels from power reactors.** Neeb, K.H.; Karnath, G.; Richter, H.; Schweighofer, W.; Stoeckert, H. (Kraftwerk Union A.G., Erlangen (Germany, F.R.). Reaktortechnik). 1975. 11p. (In German). (CONF-7509112—11). INIS.

From General meeting of the German Chemical Society; Koeln, German, Federal Republic of (F.R. Germany) (8 Sep 1975).

4 figs.; 1 tab.; 14 refs. With abstract. Available from ZAED. Will be published in J. Radioanal. Chem.

The techniques used for the investigation of ^{129}I and ^{3}H sectional distribution in highly irradiated UO_2 pellets are described. The analytical samples are taken by a micro drilling technique. For the determination of ^{129}I concentration in the UO_2 samples, neutron activation analysis following iodine separation from uranium and bulk fission products is used. ^{3}H is measured by liquid scintillation counting after distillation. The reliability of the analytical results is discussed as well as possible interferences.

2465 (DP—1418) **Behavior of tributyl phosphate in A-line processes.** Harmon, H.D.; Hyder, M.L.; Tiffany, B.; Gray, L.W.; Soltys, P.A. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). Aug 1976. Contract AT(07-2)-1. 39p. Dep. NTIS $4.00.

The chemical and physical properties of uranyl nitrate—tributyl phosphate adduct $(UO_2)(NO_3)_2(TBP)_2$ were studied to define optimum, safe operating conditions for denitration of uranyl nitrate (UN) solutions containing low concentrations of adduct. The distribution of TBP between aqueous UN solutions and organic phases (TBP pure or diluted in n-paraffin) was measured. Specific gravity measurements confirmed published data for aqueous UN solutions, but disagreed with literature data for 100 percent TBP. Intersection of the UN specific gravity curve and the 100 percent TBP data of this work indicated that phase inversion cannot occur when the aqueous phase contains greater than or

equal to 330 g U/l. Thermal decomposition of adduct occurs in one gradual weight loss step below 170°C and in two successive steps above 170°C. Rate constants for the first reaction were calculated for 130 to 210°C. The major flammable decomposition product was l-butene; inorganic gases formed were N_2, NO, N_2O, CO, and CO_2. Adduct decomposition during denitration of UN was characterized by foaming and by gas evolution (mostly nonflammable) at 135 to 185°C. Maximum flammable gas evolution and potential self-heating by TBP oxidation were calculated.

2466 (DPST-LWR—76-1-1) **Light water reactor fuel recycle. Savannah River Laboratory quarterly report, January—March 1976.** (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). 1976. Contract AT(07-2)-1. 35p. Dep. NTIS $4.00.

A preliminary economic assessment indicates that the cost advantage of closing the LWR fuel cycle becomes more pronounced as uranium ore reserves are depleted. A study showed that a recycle plant with a capacity of 10 metric tons per day of uranium and plutonium would best suit industry requirements for the mid-1980's. Evaluation of tank storage technology indicates the feasibility of tank storage of high-activity liquid waste from processing LWR fuel. Calculations showed that a 4500-MTU/year separations plant for LWR fuel would generate annually 5 million pounds (80,000 ft^3) of Zircaloy hulls containing 1.4×10^8 Ci of activation products, 2.1×10^7 Ci of fission products, and 2.1×10^4 Ci of transuranium nuclides with half-lives greater than 85 years.

2467 (ORNL/TM—5477) **LMFBR fuel recycle program progress report, July 1—December 31, 1975.** Bottenfield, B.F.; Chandler, J.M.; Duggins, B.C.; Groenier, W.S.; Holland, W.D.; Irvine, A.R.; Mailen, J.C.; Vaughen, V.C.A.; Watson, C.D.; Yarbro, O.O. (Oak Ridge National Lab., Tenn. (USA)). Aug 1976. Contract W-7405-ENG-26. 91p. AT.

The program is aimed at providing the technology for the design of commercial reprocessing facilities that will be required by the late 1990s. A hot pilot-plant process demonstration should be scheduled for 1985—90, with feed from FFTF and CRBR. Engineering studies are described. Among the laboratory and hot-cell work reported are voloxidation, RuO_2 deposits, Na deactivation, dissolution, dissolver feed, off-gas treatment, and instrumentation and control systems. For the shearing of fuel subassemblies, the plasma torch and other tools were developed and evaluated. The integrated Prototype Equipment Test facility for identifying problem areas is discussed briefly.

2468 Volatilization of iodine contained in a nitric acid solution by means of a peroxide. Cathers, G.I.; Shipman, C.J. (to USAEC, Washington, D.C.). French Patent 2243148/A/. 11 Sep 1974. 6p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France); priority claim: 11 Sept. 1973, USA.

The invention relates to the elimination of radioactive iodine from a nitric acid solution. The method consists in adding hydrogen peroxide to the solution while simultaneously maintaining the solution at its boiling point and distilling hydrogen iodide from said solution.

2469 Method for purifying nitric acid through elimination of the fluoride ions. Dietrich, W.C. (to USAEC, Washington, D.C.). French Patent 2243905/A/. 17 Sep 1974. 9p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France); priority claim: 17 Sep 1973, USA.

The invention relates to a method for eliminating fluoride-containing contaminating substances from nitric acid. The method consists in adding aluminium ions to the acid so as to form a non-distilling complex fluoride, and distilling the nitric acid once purified. This can be applied to the reprocessing of nuclear fuels and to uranium refining.

2470 Effect of gamma irradiation on extraction properties of a quaternary ammonium extractant. Contarini, M.; Pasquinelli, P.; Rigali, L. (Centro Applicazioni Militari Energia Nucleare, S. Piero a Grado (Italy)). *Radiochim. Acta;* **22**: No. 1;2, 88-90(1975).

6 figs.; 2 tabs.; 9 refs.

The influence has been studied of gamma radiation on the extraction of fission products, uranium and plutonium into Aliquat-336 and on the phase separation process of Aliquat solutions in xylene from nitric acid-water mixtures.

2471 (GERHTR—145) **HTR combustion head end comparison of the shaft furnace and fluidized bed processes.** Boehnert, R.; Kaiser, G.; Pirk, H.; Tillessen, U. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Chemische Technologie). Jan 1975. Translation of Juel—1152. 55p. Dep. NTIS $4.50.

Work performed under United States—German High Temperature Reactor Research Exchange Program.

Two methods are described for the combustion of the graphite of HTR fuel elements, a sufficient description of the principles being given to permit an understanding of the processes. The present state of the technology of the two processes is then compared on the basis of the results obtained at Gulf General Atomic. Finally, the possibilities of further development are examined using a pilot plant designed to deliver a reactor power of 7000 MWe as the basis. The present report is a collection of facts. It contains neither an evaluation nor a recommendation. A summarized comparison of the state of the technology and the possibilities of development is given in tabular form.

2472 Reprocessing of LWR fuel elements. A situation report for the Federal Republic of Germany. Roth, B.F. (Badenwerk A.G., Karlsruhe (F.R. Germany). Abt. Kernkraftwerke). *VGB Kraftwerkstech.;* **55**: No. 11, 704-708(Nov 1975). (In German).

6 figs.

The present state of reprocessing and the reprocessing capacities required in the future for the FRG and West Europe are described. The currently and in the near future available capacities of the URG (United Reprocessors GmbH), the only European reprocessing society formed of the BNFL, CEA and KEWA, essentially guarantee under contract the removal of fuel elements from German nuclear power plants only until 1976. At the latest from 1978/79 onwards, in view of the nuclear power development (for the FRG up to 1980 20,000 MW, 1985 45,000 MW), a bottleneck in reprocessing will occur as the two large plants in Windscale (BNFL) or La Hague (CEA) have made contracts for 1978 with Japan, and as the expansion and conversion of the available plants can only take place stepwise. This bottleneck until the commissioning of the planned large plant of 1,500 t/a in the FRG can be bridged by the building of 2 intermediate storage tanks each of 1,500 tU one of which should be available by 1980. The KEWA, GWR, GfRC in the framework of the reprocessing project and waste treatment (PWA), the electric supply undertaking and the state are involved in the planning of the development work, the financing and building of the large plant, where lastly the covering of the risks regarding the licensing conditions and of the transfer of the radioactive waste to the end storage is essentially done at the expense of the instigator. The required decisions, schedules, development works and cost problems connected with the 1,500 t/a plants are illustrated in several pictures.

2473 Treatment of irradiated nuclear fuel elements. Strong, R.E. (to United Kingdom Atomic Energy Authority). US Patent 3,929,961. 30 Dec 1975. Priority date 3 Feb 1970, United Kingdom of Great Britain and Northern Ireland (UK). 2p.

A treatment is described for rupturing the sheath of an elongated irradiated fuel element by subjecting the element to local induction heating. The treatment is applicable to ceramic fuel elements contained within a metal sheath. After rupture of the sheath, the fuel may be removed by dissolution. 3 claims, no drawings.

2474 Removal of iodine from reactor fuel solutions as insoluble PdI_2. Mailen, J.C.; Horner, D.E. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.;* **23**: 260(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2475 Removal of radioiodine from gas streams by electrolytic scrubbing. Mailen, J.C.; Horner, D.E. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.;* **23**: 260-261(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2476 Effects of impurities on PuO_2 dissolution in nitric—hydrofluoric acid solutions. Tallent, O.K.; Mailen, J.C. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.;* **23**: 261(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

TRANSPORT AND STORAGE

REFER ALSO TO CITATION(S) 3981

2477 (RFP-NUREG—2517) **Reference critical experiments. Progress report, January 1, 1976—March 31, 1976.** Schuske, C.L.; Dickinson, D.; Hunt, D.C.; Rothe, R.E.; Sheets, W.R. (Atomics International Div., Golden, Colo. (USA)). May 1976. Contract E(29-2)-3533. 38p. Dep. NTIS $4.00.

Calculational studies under Task 3 continue. These parametric studies are used as guidance in the planning and design of experiments. The parametric studies for Tasks 4 and 5 are 80 percent complete. The first critical measurement under Task 4 was accomplished. This measurement involved a minimally reflected single cylinder with an enriched $UO_2(NO_3)_2$ solution. Exploratory calculations for Tasks 6 and 7 continue. Approximately 75 percent of the materials and equipment needed for Task 4 and 5 experiments are on hand, and the remaining materials and equipment for these two tasks are on order. Although Task 1, "Problems and Priorities", was essentially completed and reported in RFP-NUREG-2481, we were responsible for updating Table I semiannually. This table has been appropriately re-entitled "List of Areas Where Benchmark Measurements are Needed". The first update has been accomplished.

2478 Transportation of spent nuclear fuels. Richter, D.; Birkigt, W. (Staatliches Amt fuer Atomsicherheit und Strahlenschutz, Berlin (German Democratic Republic)). *Kernenergie;* **19**: No. 3, 73-82(1976). (In German).

During operation of a nuclear power plant some 10 tons of irradiated uranium per year and gigawatt installed electric power have to be transported from the nuclear power plant to the reprocessing plant. The high content of radioactive fission products in the order of magnitude of 1 MCi/t U, the generation of residual heat of 1 to 20 kW/t U arising from them, and the content of fissionable materials amounting to a multiple of the critical mass represent a potential risk in public transportation. Safety in transportation of spent nuclear fuels is warranted on the basis of international regulations for the transport of radioactive materials. In estimating safety, the necessary shipping casks and flasks are of special importance. Long-term international experience is available in the field of spent nuclear fuel transportation. A review of transportation practice in various countries is given.

2479 Nuclear shipments: where we are and where are we going. Brobst, W.A. (Energy Research and Development Administration, Washington, DC). *Trans. Am. Nucl. Soc.;* **23**: 88(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2480 Summary of the basic regulatory requirements for the transport of radioactive materials. Grella, A.W. (Dept. of Transportation, Washington, DC). *Trans. Am. Nucl. Soc.;* **23**: 88(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2481 Overview of risk assessment in transportation of radioactive materials. Hopkins, D.R.; Barker, R.F.; Tse, A.N. (Nuclear Regulatory Commission, Washington, DC). *Trans. Am. Nucl. Soc.;* **23**: 88-89(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2482 Development of industry standards for transport of radioactive materials. Langhaar, J.W. (E. I. duPont de Nemours and Co., Wilmington, DE). *Trans. Am. Nucl. Soc.;* **23**: 89-90(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2483 Techniques for evaluating risks from the transport of radioactive materials. Hall, R.J.; Williams, L.D. (Battelle Pacific Northwest Labs., Richland, WA). *Trans. Am. Nucl. Soc.;* **23**: 90(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2484 Comparison of risk assessments of Pu released during transport. Resnikoff, M. (Rachel Carson Coll., Amherst, NY). *Trans. Am. Nucl. Soc.;* **23**: 90-91(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2485 Risk in transporting radioactive materials. Luna, R.E.; Smith, D.R.; DuCharme, A.R.; Taylor, J.M. (Sandia Labs., Albuquerque, NM). *Trans. Am. Nucl. Soc.;* **23**: 91-92(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

MARKETING AND ECONOMICS

2486 (INIS-mf—3039) **Uranium.** Stewart, E.D.J. (Australasian Inst. of Mining and Metallurgy, Parkville (Australia)). 1974. 32p. (CONF-741195—1). INIS.

From Symposium on energy resources; Canberra, Australia (8 Nov 1974).

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A discussion is given of uranium as an energy source in The Australian economy. Figures and predictions are presented on the world supply-demand position and also figures are given on the added value that can be achieved by the processing of uranium. Conclusions are drawn about Australia's future policy with regard to uranium.

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 2475, 2545, 3322, 3570, 3955

2487 (INIS-mf—3053) **Canadian program for management of spent fuel and high level wastes.** Barnes, R.W.; Mayman, S.A. (Atomic Energy of Canada Ltd., Pinawa, Manitoba. Whiteshell Nuclear Research Establishment). [nd]. 31p. INIS.

A brief history and description of the nuclear power program in Canada is given. Schedules and programs are described for storing spent fuel in station fuel bays, centralized water pool storage facilities, concrete canisters, convection vaults, and rock or salt formations. High-level wastes will be retrievable initially, therefore the focus is on storage in mined cavities. The methods developed for high-level waste storage/disposal will ideally be flexible enough to accommodate spent fuel.

2488 Materials considerations in radioactive waste management: an introduction. Eister, W.K. (Energy Research and Development Administration, Washington, DC). *Trans. Am. Nucl. Soc.;* **23**: 159(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2489 Hanford waste encapsulation: strontium and cesium. Jackson, R.R. (Atlantic Richfield Hanford Co., Richland, WA). *Trans. Am. Nucl. Soc.;* **23**: 159-160(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2490 Evaluation of the TRU waste problem in the commercial nuclear industry. Dunne, J.F.; O'Hara, F.A. (Ohio State Univ., Columbus). *Trans. Am. Nucl. Soc.;* **23**: 262(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2491 Analysis of actinide depletions and radiotoxic hazards following irradiation in a fusion—fission hybrid reactor. Chi, J.W.H.; Kellman, S.; Klein, D.; Rose, R.P. (Westinghouse Electric Corp., Pittsburgh). *Trans. Am. Nucl. Soc.;* **23**: 262-263(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2492 Plutonium burnout in fast reactors as a waste management alternative. Beaman, S.L.; Bailey, H.S. (General Electric Co., Sunnyvale, CA). *Trans. Am. Nucl. Soc.;* **23**: 263-264(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

WASTE PROCESSING

REFER ALSO TO CITATION(S) 2452, 2468, 2530, 2543, 3575, 4153

2493 (AED-CONF—75-571-003) **Separation of fission iodine in nuclear power stations and reprocessing plants.** Wilhelm, J.G.; Deuber, H.; Dillmann, H.G.; Furrer, J. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Lab. fuer Aerosolphysik und Filtertechnik). 1975. 20p. (In German). (CONF-751191—1). INIS.

From Annual meeting of the project nuclear safety; Karlsruhe, German, Federal Republic of (F.R. Germany) (11 Nov 1975).

7 figs.; 4 tabs.; 14 refs.

Reprocessing tests in iodine filtering systems in nuclear power plants which were carried out by means of control filters on iodine sorption filters showed partly a very great reduction of the degree of separation, particularly with plants which have only recently been put into operation. The cause was found to be the absorption of filter poisons which are released by coatings and synthetics. To improve this, the effect of pre-filters was investigated. Investigations with simulated loss-of-coolant accidents are reported. Activated carbon filters can no longer be considered for accident air recirculating filters due to the ignition hazard. Drop separators and inorganic iodine sorption materials have taken their place. Test series are being performed to determine the degree of separation and to be able to predict maximum environmental exposures. The investigations are also extended to conditions in reprocessing plants. Wet-washing processes, amongst others, as well as iodine separators are included in special iodine sorption materials here. The effect of organic poisons including organic iodine compounds is of particular interest.

2494 (ARH-ST—132c) **Technology development for long-term management of Hanford high-level waste. Quarterly report, January 1976—March 1976 .** Kounts, J.S. (ed.). (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). Jun 1976. Contract E(45-1)-2130. 69p. Dep. NTIS $4.50.

This document is the seventh in a series of quarterly reports on work in support of long-term management of Hanford high-level wastes. The work reported here was performed during the period January through March 1976. The specific topics discussed are grouped into the subject areas of: Storage System Integrity and Engineered Improvements; Waste Retrieval; Waste Immobilization and Storage; Contaminated Equipment Volume Reduction; and Analytical Methods Development. Previous reports were published as ARH-ST-110 A through D and ARH-ST-132 A and B.

2495 (BNL—21571) **Some techniques for the solidification of radioactive wastes in concrete.** Colombo, P.; Neilson, R. Jr. (Brookhaven National Lab., Upton, N.Y. (USA)). Jun 1976. Contract E(30-1)-16. 29p. (CONF-760622—5). Dep. NTIS $4.00.

From American Nuclear Society 1976 annual meeting; Toronto, Ontario, Canada (13 Jun 1976).

Some techniques for the solidification of radioactive wastes in concrete are discussed. The sources, storage, volume reduction, and solidification of liquid wastes at Brookhaven National Laboratory (BNL) using the cement-vermiculite process is described. Solid waste treatment, shipping containers, and off-site shipments of solid wastes at BNL are also considered. The properties of low-heat-generating, high-level wastes, simulating those in storage at the Savannah River Plant (SRP), solidified in concrete were determined. Polymer impregnation was found to further decrease the leachability and improve the durability of these concrete waste forms.

2496 (CONF-760701—9) **Removal of particulates from nuclear offgas.** Burchsted, C.A. (Oak Ridge National Lab., Tenn. (USA)). 1976. Contract W-7405-Eng-26. 16p. Dep. NTIS $3.50.

From International symposium on management of waste from the LWR fuel cycle; Denver, Colorado, United States of America (USA) (11 Jul 1976).

Particulate removal from nuclear offgases can be broken down into three parts: pretreatment, prefiltration, and absolute filtration. Pretreatment, using conventional air cleaning devices in most cases, is sometimes required to temper the gases and remove heavy concentrations of particulate matter. Prefiltration, if required, serves primarily to protect the final filter stages from heavy dust loadings in order to extend their life. HEPA filters are the most commonly used "absolute" filtration devices and are always required for removal of submicrometer particulates that cannot be removed effectively by other devices.

2497 (COO—2510-11) **Advanced waste forms research and development. Annual report.** McCarthy, G.J. (Pennsylvania State Univ., University Park (USA). Materials Research Labs.). 11 Jun 1976. Contract E(11-1)-2510. 45p. Dep. NTIS $4.00.

Thermogravimetric analysis on cesium aluminosilicates was performed. Pollucite, $CsAlSi_2O_6$, appears to have more than adequate thermal stability for Cs fixation in supercalcine. The possibility of leaving Ru as RuO_2 during supercalcine crystallization is being assessed. The apatite solid solution [A/sub ss/] phases used in supercalcine phase formation models have been easily prepared as pure phases. Use of Ca instead of Sr as an alkaline earth additive yields a more stable A/sub ss/ phase. Weight ratios have been optimized for two firing temperatures in terms of soxhlet leachability. However, this is not the preferred approach to supercalcine consolidation. The phase formation models developed for PW-4b-type wastes were routinely applied to PW-7, in spite of several significant composition differences in the latter. Uranium oxide remains as a fluorite structure oxide after supercalcine crystallization, but it does seem to have incorporated either or both CeO_2 or ZrO_2. Characterization of this F/sub ss/ phase will require further study. Based on observations during several complex compatibility studies, it appears that good overall thermal stability at as high as 1200°C might be attainable for nepheline based supercalcine formulations. A thorough literature review of the oxide crystal chemistry of Te has been completed.

2498 (DP—1417) **Denitration of Savannah River Plant waste streams.** Orebaugh, E.G. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). Jul 1976. Contract E(07-2)-1. 28p. Dep. NTIS $4.00.

Partial denitration of waste streams from Savannah River Plant separations processes was shown to significantly reduce the quantity of waste solids to be stored as an alkaline salt cake. The chemical processes involved in the denitration of nonradioactive simulated waste solutions were studied. Chemical and instrumental analytical techniques were used to define both the equilibrium concentrations and the variation of reactants and products in the denitration reaction. Mechanisms were proposed that account for the complicated chemical reactions observed in the simulated waste solutions. Metal nitrates can be denitrated by reaction with formic acid only by the release of nitric acid from hydrolysis or formate complexation of metal cations. However, eventual radiolysis of formate salts or complexes results in the formation of biocarbonate and makes complexation-denitration a nonproductive means of reducing waste solids. Nevertheless, destruction of nitrate associated with free acid and easily hydrolyzable cations such as iron, mercury, and zirconium can result in greater than 30 percent reduction in waste solids from five SRP waste streams.

2499 (GERHTR—149) **FIPS: a process for the solidification of fission product solutions using a drum drier.** Halaszovich, S.; Laser, M.; Merz, E.; Thiele, D. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Chemische Technologie). 1976. 15p. (CONF-760310—8; SM—207/19). Dep. NTIS (US Sales Only) $3.50.

From IAEA symposium on the management of radioactive waste; Vienna, Austria (22 Mar 1976).

Work performed under United States—German High Temperature Reactor Research Exchange Program.

A new process consisting of the steps concentration of the fission product solution, denitration of the solution by addition of formaldehyde, addition of glass-forming additives, drying of the slurry using a drum drier, melting of the dry product in the crucible by rising level in-pot-melting, and off-gas treatment and recovery of nitric acid is under development. A small plant with a capacity of 1 kg glass per hour has been tested in hot cells with fission product solutions from LWR fuel element reprocessing since December 1974. The equipment is very simple to operate and to control. No serious problems arose during operation.

2500 (HW—73456) **Anion exchange flow sheets and equipment for recovery of Task I filtrates.** Crocker, H.W. (General Electric Co., Richland, Wash. (USA). Hanford Atomic Products Operation). 23 Apr 1962. Contract W-31-109-eng-52. 10p. Dep. NTIS $3.50.

The filtrate stream from the precipitation—filtration step of the Button Line process must be recycled to recovery operations to reclaim residual plutonium. Present practice is to transfer the filtrates to Recuplex, concentrate by a factor of 6 to 10, and blend into the feed stream for solvent extraction purification. Limited tankage is available for solution storage. Interruption of Recuplex operations necessitates termination of operations in the precipitation-filtration steps and other Button Line areas. Filtrates can be recycled to one of the parent solvent extraction plants for recovery. However, excessive handling operations are encountered by this processing method. This document describes the anion exchange flow sheets and equipment for processing the filtrate stream without dependence upon other recovery operations.

2501 (KFK—2162) **Experimental studies on the possibility of using a ceramic matrix for fixing the high level radioactive wastes.** Husain, S.R.; Rudolph, G.; Hild, W. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Projekt Wiederaufarbeitung und Abfallbehandlung; Kernforschungszentrum Karlsruhe (Germany, F.R.). Abt. Behandlung Radioaktiver Abfaelle). Jun 1975. 28p. (PWA—1/75). INIS.

7 figs.; 2 tabs.; 7 refs.

A ceramic product has been developed to fix high level radioactive wastes for storage and final disposal. In the present experiments some of the properties, e.g., visual change, change in size or shape, change in weight, change in structure, density and leachability, are studied for the long term stability of the product under heat and radiation treatment. The properties are not severely affected by radiation or by heat treatment. The leaching property is slightly affected due to heating. From the results it appears

that the heating has a dominant effect over the radiation on the properties of the ceramic product.

2502 (ORNL-MIT—152) **Characterization of decontamination factors for evaporators used in the treatment of low and intermediate level liquid radioactive wastes.** Rood, L.B.; Law, C.G. Jr. (Oak Ridge National Lab., Tenn. (USA)). 26 Sep 1972. Contract W-7405-ENG-26. 31p. Dep. NTIS $4.00.

Evaporator decontamination factors were studied as functions of boiloff rate, volume reduction, and feed pH. A bench-scale vertical tube evaporator operating on simulated intermediate level nuclear wastes was used. Decontamination factors were not found to be strong functions of volume reduction or boiloff below vapor velocities of 25 lb/ft^2-hr. At higher vapor fluxes, splashing was encountered. Foaming occurred at a feed pH of 6 but not at higher values. The presence of radioisotopes in the feed had no effect on evaporator performance.

2503 (SGAE—2518) **Bitumination of solid radioactive residues by sedimentation in the final storage vessel.** Knotik, K.; Leichter, P.; Jakusch, H.; Glock, J. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Vienna). Nov 1975. 10p. (In German). (CONF-751030—3). INIS.

From International nuclear industries fair; Basel, Switzerland (7 Oct 1975).

Experience obtained with the sedimentation technique during trial solidification of nonactive evaporation residues in bitumen is presented. The properties of the final product as well as improvements to reach continuous operation together with simplified decontamination are discussed.

2504 (TID—3311-S7) **Radioactive waste processing and disposal.** (Energy Research and Development Administration, Oak Ridge, Tenn. (USA). Technical Information Center). Aug 1976. 305p. Dep. NTIS $9.75.

References to 1841 publications related to radioactive waste, announced in Nuclear Science Abstracts (NSA) Volumes 31 (Jan.—June 1975), 32 (July—Dec. 1975), and 33 (Jan.—June 1976), are cumulated in this bibliography. The references are arranged by the original NSA abstract number, which approximately places them in chronological order. Sequence numbers appear beside each reference and the NSA volume and abstract number appears at the end of each bibliographic citation. A listing of the subject descriptors used to describe each reference for machine storage and retrieval is shown. Four indexes are provided: Corporate Author, Personal Author, Subject, and Report Number. These indexes refer to the sequence numbers for the references.

2505 Removal of tritiated species from gas streams comprised thereof. (to Engelhard Minerals and Chemicals Corp., Newark, N.J. (USA). Engelhard Industries Div.). Australian Patent 74/72674/A/. 26 Aug 1974. 25p.

Open to public inspection 26 Feb 1976, priority USA 27 Aug 1973, copies available from the Commissioner of Patents, Canberra.

A process is described for the removal of radioactive tritium, and/or compounds of tritium, from a gas stream by reacting the tritium or tritium compounds such as tritiated water, and/or tritiated hydrocarbons [hereinafter the 'tritiated species'] over a precious metal catalyst with sufficient air or oxygen to convert all of the tritiated species to tritiated water and, in the case of hydrocarbons, to carbon dioxide. At this point in time, all of the tritium has been converted to tritiated water. The tritiated water, and any other moisture that might be present in the gas stream, is then adsorbed by a desiccant dryer to less than about one part per million total water. Preferably, the effluent from the desiccant dryer is next swamped or flooded with ordinary non-radioactive water [proton oxide, or even deuterium oxide for that matter] to dilute the tritiated water by a factor of at least about 1,000:1.

2506 Development of fission iodine separation for nuclear power plants and reprocessing plants during normal operation and accidents. Wilhelm, J.G.; Deuber, H.; Dillmann, H.G.; Furrer, J. (Kernforschungszentrum Karlsruhe (F.R. Germany). Lab. fuer Aerosolphysik und Filtertechnik). *KFK Nachr.*; **7**: No. 3, 58-62(1975). (In German).

9 figs.; 8 refs.

A report is given on present research and development works on fission iodine separation. The influence of filter poisons is particularly investigated, and tests are carried out on the retaining by pre-filtering. For accident conditions, special inorganic iodine sorption materials are used and tested instead of activated carbon filters. A self-equipped test stand enables the simulation of high temperatures and moisture. The separation behavior of suspended matter filters can thus also be investigated. Iodine compounds are particularly considered in iodine separation. Discriminating iodine collectors are used to control the former. KI-impregnated activated carbon is used in the separation of organic iodine compounds. Drum filters are under development for use in reprocessing plants. The sorption materials are produced in such a manner as to be most suitable for final storage.

2507 Method and equipment for the evaporation of liquids, in particular for the decontamination of radioactively contaminated waste waters. Kochwasser, F. (to Chemie Apparatebau Mainz Schmahl und Dinckels G.m.b.H. (F.R. Germany)). German(FRG) Patent 2361791/A/. 19 Jun 1975. 19p. (In German).

4 figs.

Radioactively contaminated waste water is decontaminated with a one-stage evaporation device with two-phase separation. The device consists of the one-stage evaporator with an inlet pump, a heat exchanger and a vapour separator as well as the condensation equipment with condenser, gas cooler, gas expeller and distillate cooler. The waste water is pumped through the circuit between evaporator and vapour separator. The radioactive liquid particles contained in the vapour after the escape from the vapour separator are condensed in a settler chamber and the remaining vapour is agglomerated by means of jet atomized liquid and is then also condensed in a further separator. The separated liquids are led back into the cleaning cycle. The reflux liquid fed into the vapour separator is used as washing liquid for the vapours. The atomized liquid for the agglomeration is produced from the system's own distillate from the gas expeller with a Venturi nozzle. The distillate from the distillate cooler is the purified waste water collected in the form of vapour.

2508 Possibilities of the extraction and application of low-activity fission products from high-activity nuclear fuel wastes. Koch, H.; Schober, A. (Akademie der Wissenschaften der DDR, Leipzig. Zentralinstitut fuer Isotopen- und Strahlenforschung). *Isotopenpraxis;* **12**: No. 2, 49-56(1976). (In German).

The possibilities of an economical extraction and technical application of low-activity fission products (krypton, xenon, rhodium, palladium, ruthenium, technetium) from radioactive wastes are shown. A survey is presented on the production, properties and quantities of fission products in nuclear fuel, on their application, the demand to be expected by the year 2000, and the supply from natural resources, as well as the economic prospects of pilot plants producing fission products.

2509 Formation, treatment and storage of radioactive waste from nuclear power stations. *Electro-Rev.*; **68**: No. 10, 210-212, 215-217(9 Mar 1976). (In German and French).

This general article deals with radioactive waste products disposal and explains how fission products form in fuel elements. It differentiates between weak, intermediate and highly radioactive products, solid, liquid or gaseous. A report on the first transportation - April to July 1975 - of 74 irradiated fuel elements from the Muehleberg reactor in Switzerland to the French irradiated fuel processing plant at La Hague is included. It is concluded that the radioactive waste disposal problem is completely resolvable.

2510 Iodine decontamination factor for liquid radioactive waste volume reduction system. Tokerud, L.D.; Garcia, R. (Aerojet Energy Conversion Co., Sacramento, CA). *Trans. Am. Nucl. Soc.*; **23**: 264(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2511 Immobilization of ^{129}I as barium iodate with Portland cement. Clark, W.E. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.*; **23**: 264-265(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2512 Packaging Rocky Flats waste. Wickland, C.E. (Rockwell International, Golden, CO). *Trans. Am. Nucl. Soc.*; **23**: 161(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2513 Some techniques for the solidification of radioactive wastes in concrete. Colombo, P.; Neilson, R.M. Jr. (Brookhaven National Lab., Upton, NY). *Trans. Am. Nucl. Soc.*; **23**: 161-162(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2514 Packaging of tritium-contaminated liquid waste. Mershad, E.A. (Brookhaven National Lab., Upton, NY); Colombo, P.; Thomasson, W.W.; Dauby, J.J. *Trans. Am. Nucl. Soc.*; **23**: 163-164(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2515 **Nuclear reactor operation wastes.** Tarnuzzer, E.C. (Yankee Atomic Electric Co., Westboro, MA). *Trans. Am. Nucl. Soc.*; **23**: 165-166(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2516 **Canadian spent-fuel storage canister: some materials aspects.** Boase, D.G.; Vandergraaf, T.T. (Whiteshell Nuclear Research Establishment, Pinawa, Manitoba). *Trans. Am. Nucl. Soc.*; **23**: 166(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2517 **Experts mull over radioactive waste disposal.** *Chem. Eng. News*; **54**: No. 32, 21-24(2 Aug 1976).

The experts met last month in Denver at an International Symposium on the Management of Wastes from the LWR fuel cycle. Development of nuclear power and reprocessing of the resulting waste in the European countries and the U.S. are discussed. The need for international cooperation and standards is pointed out. Decommissioning of old reactors and facilities is also considered. (DLC)

WASTE DISPOSAL AND STORAGE

REFER ALSO TO CITATION(S) 2494, 2497, 2501, 2504, 2509, 2517

2518 (BNL—21700) **Tritium storage development. Progress report No. 7, January—March 1976.** (Brookhaven National Lab., Upton, N.Y. (USA)). 1976. Contract E(30-1)-16. 22p. Dep. NTIS $3.50.

Polymer impregnation was shown to greatly improve the leach rate of tritiated concrete specimens on a laboratory scale. This technique is proposed for the disposal of high-level tritiated aqueous waste. Work was directed towards the development of a soak impregnation technique for large-scale samples. Four cylindrical specimens of polymer impregnated tritiated concrete (PITC) 27 cm x 28 cm long, each containing 10 Ci tritium, were produced and buried without containers in individual lysimeters at the Savannah River Plant; they are being monitored. To date, no tritium release has been noted in water or air samples taken from these lysimeters. A duplicate PITC sample also containing 10 Ci tritium was placed in static leaching in distilled water. After thirty-two days of leaching, the average fraction tritium release rate was 1.82×10^{-5} per day. A technique using an injector to distribute aqueous tritiated waste in dry cement prior to impregnation is under development. This injector method is more compatible with the glove box operations in use with high level tritiated aqueous waste than end-over-end drum tumbling. Initial PITC specimens have been produced using this technique.

2519 (COO—2689-5) **Seabed disposal program: geochemical and sedimentological studies of North Pacific sediments. Progress report, April 1, 1976—June 30, 1976.** Heath, G.R. (Rhode Island Univ., Kingston (USA). Graduate School of Oceanography). Jul 1976. Contract E(11-1)-2689. 4p. Dep. NTIS $3.50.

Studies of sorption equilibria between end-member (illite-rich) and (smectite-rich) clays from the MPG-2 area (33°20'N, 151°00'W) and $ThCl_4$ and UO_2Cl_2 solutions in 0.7M NaCl, distilled water and artificial seawater have shown that partition coefficients vary with clay type, concentration of U or Th solution, temperature and presence of other ions.

2520 (KFK—2170) **Long-range behaviour of HLW glasses: a contribution to the evaluation of problems related to the disposal of a α-bearing waste from reprocessing and fuel-element-production.** Scheffler, K.; Riege, U.; Hild, W.; Jakubick, A.T. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Projekt Wiederaufarbeitung und Abfallbehandlung; Kernforschungszentrum Karlsruhe (Germany, F.R.). Abt. Behandlung Radioaktiver Abfaelle). Jul 1975. 51p. (In German). (PWA—10/75). INIS.

16 figs.; 3 tabs.; 14 refs.

An evaluation of questions concerning the safety aspects during perpetual storage of radioactive wastes is performed on the basis of the concentration of α-emitters in the wastes, the relative toxicities of these α-emitters and the long-range stability of the solidified products towards the disintegration of these α-nuclides. In this context an overview is given on all categories of α-bearing wastes from fuel reprocessing and refabrication. As an example the long-range behaviour of high-level waste glasses is discussed and investigated by an accelerated experiment with representative Cm-242 spiked glass compositions.

2521 (LA-UR—76-1722) **Burial grounds.** Wheeler, M.L. (Los Alamos Scientific Lab., N.Mex. (USA)). 1976. Contract W-7405-ENG-36. 16p. (CONF-760701—11). Dep. NTIS $3.50.

From International symposium on management of waste from the LWR fuel cycle; Denver, Colorado, United States of America (USA) (11 Jul 1976).

Major burial facilities for the disposal of radioactive waste are presently operated at five Energy Research and Development Administration (ERDA) facilities, and at six commercial sites. This paper describes the history and present operations at all commercial sites, including the waste types received, burial techniques used, present radionuclide inventory, licensing procedures, and the nature of plans for ultimate disposition of the sites. The containment capability of the various sites is analyzed through a description of the hydrogeology of each site, the present monitoring programs, and any observed radionuclide migration. Similar descriptions of ERDA-operated sites are included to provide a thorough understanding of present radioactive waste burial practices. None of the radionuclide migration at ERDA or commercial sites has endangered public health or safety. However, in keeping with the concept that radionuclide releases to man's environment should be as low as practicable, modifications to present burial practices are discussed that could improve the containment capability of existing sites.

2522 (ORNL/TM—5545) **Shale fracturing injections at Oak Ridge National Laboratory: 1975 series.** Weeren, H.O. (Oak Ridge National Lab., Tenn. (USA)). Aug 1976. Contract W-7405-eng-26. 69p. Dep. NTIS $5.00.

Intermediate level waste solution generated at ORNL is periodically mixed with a cement base blend of dry solids and injected into an impermeable shale formation at an approximate depth of 800 ft. Shortly after the injection the grout mix sets, permanently fixing the radionuclides in the shale formation. A series of three injections of intermediate level waste solution was made in 1975. A total of 190,000 gal of waste solution containing 86,700 Ci of radionuclides was injected. This report is an account of this injection series— preparations, injections, results, and conclusions. A summary of the volumes and activities that were injected is given.

2523 (SAND—76-0077) **Mechanics analysis for deep rock disposal of radioactive wastes.** Bertram, L.A. (Sandia Labs., Albuquerque, N.Mex. (USA)). Jul 1976. Contract AT(29-1)-789. 45p. Dep. NTIS $4.00.

The deep rock disposal method using monolithic cylindrical geometry is examined using simplified analyses of conductive thermal solutions, thermal stresses, phase changes, and convective phenomena. The results indicate that mechanisms exist which could allow fission product migration through all near-axis barriers. It is therefore recommended that migration of fission products through virgin rock at depth be carefully considered. To determine whether the near-axis barriers do in fact fail will require a detailed solution, some features of which are available in existing codes but which is beyond the current state of the art in its fully-coupled form. A short discussion of other versions of deep rock disposal, in light of the present results, is included.

2524 (SAND—76-5319) **Interaction of a glass-based nuclear waste simulant and natural rock.** Hlava, P.F.; Chambers, W.F. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1976. Contract AT(29-1)-789. 10p. (CONF-760803—10). Dep. NTIS $3.50.

From 34. Electron Microscopy Society of America annual meeting; Miami Beach, Florida, United States of America (USA) (9 Aug 1976).

A simulant glass containing stable isotopes was inserted into a hole bored into a microgabbro block; the "waste" was maintained in the molten state for approximately 1 month by resistive heating. After cooling, the block was sectioned and examined by x-ray fluorescence. Among the colored zones within the glass was found a narrow white band (convection flow boundary). This boundary and other layers were analyzed using an electron microprobe. Within the melted region, a convection cell was formed which kept the central part of the cell well mixed. The white band contains small pyroxene crystals. Four crystalline phases grew from the melt: two oxides, a borate, and a silicate. Small spinel crystals of MgO, NiO, Cr_2O_3, and $FeO(Fe_2O_3)$ are dispersed throughout the melt. In the central part of the convection cell, clusters of skeletal Mg- Fe-borate crystallites are found. A silicate similar to $CaMaSi_2O_6$ formed in the side of the convection cell and in the white band. (DLC)

2525 (SAND—76-5653) **Report to the Radioactive Waste Management Committee on the first international workshop on**

seabed disposal of high-level wastes. Anderson, D.R.; Hollister, C.D.; Talbert, D.M. (eds.). (Sandia Labs., Albuquerque, N.Mex. (USA)). 1976. Contract E(29-1)-789. 34p. (CONF-760230—1). Dep. NTIS $4.00.

From 1. international workshop on seabed disposal of high-level wastes; Woods Hole, Massachusetts, United States of America (USA) (16 Feb 1976).

The basic conclusion of the workshop is that, while a very considerable amount of work must be done to assure safety and feasibility, no technical reasons are apparent at this moment that would preclude disposal of radioactive wastes underneath the seafloor. Subsidiary conclusions reached by subgroups dealing with undersea geology, biology, the water column, and disposal canister research are given. General conclusions reached by the workshop are detailed, together with proposals for an international program furthering an undersea disposal scheme.

2526 (Y/OWI—7) Waste isolation in geologic formations in the USA. Zerby, C.D.; McClain, W.C. (Oak Ridge Y-12 Plant, Tenn. (USA)). 1976. Contract W-7405-eng-26. 22p. (CONF-760701—10). Dep. NTIS $3.50.

From International symposium on management of waste from the LWR fuel cycle; Denver, Colorado, United States of America (USA) (11 Jul 1976).

The ERDA program for the establishment of terminal storage facilities for commercial radioactive wastes in deep geologic formations was recently reorganized as the National Waste Terminal Storage (NWTS) program. General plans for implementing this expanded program call for geologic investigations and feasibility confirmation studies at multiple geographic locations, leading to pilot plant construction and operation with possible future conversion into a Federal Repository. The pilot plant operations will be experimental facilities having limited capacity to store actual waste in a readily retrievable configuration. The first two pilot plants are planned to start operations simultaneously in the mid-1980's. Geologic investigations are now in progress or planned in study areas of the interior basins of the Gulf Coast Salt Dome Province, in the Salina Salt basin and in the Paradox Basin in an effort to identify acceptable locations for these initial facilities. Subsequent pilot plants will be located in other formations. Preliminary geologic evaluations have been initiated in the Paleozoic shales and limestones, Triassic shale basins along the east coast, Mesozoic shales of the Gulf Coast and northern high plains and certain crystalline igneous rocks. Most of the required engineering testing of disposal in salt formations has been completed in previous programs. However, the establishment of pilot plants in the other rock types will require a sequence of in situ testing designed to develop the information necessary to both demonstrate the feasibility of waste disposal in that particular formation and provide the data for facility designs.

2527 Radiation protection and safety in nuclear waste disposal. With special regard to the disposal of highly active wastes. Breest, H.C.; Holtzem, H. (Bundesministerium des Innern, Bonn (F.R. Germany)). *Atomwirtsch., Atomtech.;* **20**: No. 12, 607-610(Dec 1975). (In German).

A more detailed version of this paper will be published in Jahrbuch der Atomwirtschaft 1976.

For nuclear technology to function properly not only regular operation of nuclear power stations with a guaranteed supply of nuclear fuel is needed, but also, and very much so, a feasible and reliable solution of the waste disposal problem must be found. This implies that problems both of waste disposal and of the safe secular storage of special nuclear materials, especially of plutonium, must be solved, for instance by recycling. Measures of radiation protection, safety and security, supplemented by nuclear safeguards and nuclear liability provisions, must provide sufficient protection to the public from the hazards of nuclear technology. In estimating the risk, a careful distinction must be made between the theoretical hazard potential (activity and relative radiotoxicity), the radiation exposure to be expected on the basis of the protective measures at hand, and the risk of an actual radiation damage, which is a function of the dose effect relationships. A realistic assessment must be based on a probabilistic approach to the problem.

2528 Concept and construction of a storage basin for medium-activity liquid wastes in consideration of outside influences. Herrmann, G. (Gesellschaft zur Wiederaufarbeitung von Kernbrennstoffen m.b.H., Eggenstein-Leopoldshafen (F.R. Germany)); Pirk, H. (Nuklear-Chemie und -Metallurgie G.m.b.H. (NUKEM), Hanau (F.R. Germany)). pp 490-493 of In Reactor conference, Duesseldorf, 30.3.-2.4.1976. Section 2: Fuel elements, fuel cycle and isotope technique. Eggenstein-Leopoldshafen, F.R. Germany; ZAED (1976). (In German)

From Reactor meeting; Duesseldorf, F.R. Germany (30 Mar 1976).

Short communication only.

2529 Radioactive waste inventory at the Maxey Flats nuclear waste burial site. Gat, U.; Thomas, J.D. (Kentucky Univ., Lexington (USA)); Clark, D.T. *Health Phys.;* **30**: No. 3, 281-289(Mar 1976).

The Radioactive Shipment Records for the Maxey Flats low level nuclear waste burial site near Morehead, Kentucky, have been made computer accessible. The correction of mistakes in the records is described. The waste inventory of the site as on the records is calculated. Inventory is given by several classifications: activity for site and burial pits; accumulated activity by isotopes; waste volume. Several of the activities are given as deposited, at the present time and some are calculated as they will be in the future. Some comparisons are made with other methods of inventory accounting. It is shown that present records are not completely reliable; possible reasons for mismatching are postulated.

2530 German project for radioactive waste disposal. *Electro-Rev.;* **68**: No. 14, 313-314(6 Apr 1976). (In German and French).

The results are summarized of a plan, outlined at a symposium attended by government, research and industrial representatives, in January 1976 at Mainz, for the storage, reprocessing and final disposal of radioactive waste at a special site in the Federal Republic.

2531 Borehole plugging by melted in-situ rocksalt. Black, D.L.; Fernandes, R. (Westinghouse Astronuclear Lab., Pittsburgh). *Trans. Am. Nucl. Soc.;* **23**: 265(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2532 Stabilization and storage of solidified high-level radioactive wastes. Berreth, J.R.; Hoskins, A.P.; Rindfleisch, J.A. (Allied Chemical Corp., Idaho Falls, ID). *Trans. Am. Nucl. Soc.;* **23**: 160-161(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2533 Leach behavior of hydrofracture grout incorporating radioactive wastes. Moore, J.G.; Godbee, H.W.; Kibbey, A.H. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.;* **23**: 162-163(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2534 High-level waste glass. Mendel, J.E. (Battelle-Pacific Northwest Labs., Richland, WA). *Trans. Am. Nucl. Soc.;* **23**: 166-167(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2535 High-level waste glass: field leach test. Merritt, W.F. (Chalk River Nuclear Labs., Ont.). *Trans. Am. Nucl. Soc.;* **23**: 167-168(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2536 High-level waste ceramics. McCarthy, G.J. (Pennsylvania State Univ., University Park). *Trans. Am. Nucl. Soc.;* **23**: 168-169(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2537 Chop-leach fuel bundle residues densification by melting. Nelson, R.G.; Griggs, B. (Battelle Pacific Northwest Labs., Richland, WA). *Trans. Am. Nucl. Soc.;* **23**: 169(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2538 Actinide transmutation studies: a review. Croff, A.G. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.;* **23**: 545(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2539 Feasibility studies of actinide recycle in LMFBRs as a waste management alternative. Beaman, S.L.; Aitken, E.A. (General Electric Co., Sunnyvale, CA). *Trans. Am. Nucl. Soc.;* **23**: 547-548(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2540 Actinide destruction in a 1500-MW(e) carbide-fueled LMFBR. Prabulos, J.J. (Combustion Engineering, Inc., Windsor, CT). *Trans. Am. Nucl. Soc.*; **23**: 548-549(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2541 Actinide transmutation in fusion reactor blankets. Jenquin, U.P.; Leonard, B.R. Jr. (Battelle Pacific Northwest Labs., Richland, WA). *Trans. Am. Nucl. Soc.*; **23**: 549-551(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2542 Actinide transmutation: cross sections, methods, and reactor sensitivity studies. Morrison, G.W.; Burns, T.J.; Weisbin, C.R. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.*; **23**: 552-553(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 3081, 3806, 3815, 3844, 3852, 3977

2543 (ORNL/TM—5284) **Progress report on evaluation of potential impact of ^{14}C releases from an HTGR reprocessing facility.** Killough, G.G.; Dixon, K.R.; Edwards, N.T.; Murphy, B.D.; Rohwer, P.S.; Harris, W.F.; Kaye, S.V. (Oak Ridge National Lab., Tenn. (USA)). Jul 1976. Contract W-7405-eng-26. 98p. Dep. NTIS $5.00.

The potential radiological impacts of atmospheric releases of $^{14}CO_2$ are assessed for a model HTGR reprocessing facility. Two off-gas systems were considered: (1) a 300-ft stack with no thermal output, and (2) a 1000-ft stack with a stack gas temperature of 80°C and heat output of 4.2×10^7 Btu/hr. Meteorological data for the Oak Ridge area were used with an assumed annual release rate of 5000 Ci as input to an atmospheric transport model, which in turn was used to predict air concentrations of ^{14}C at points of habitation and food production in the local area (within 50 miles) of the facility. The total-body dose rates estimated for the average resident living in the local area were 0.107 mrem/yr for the 300-ft stack and 0.063 mrem/yr for the 1000-ft stack. Population doses were computed for a population of 10^6 individuals uniformly distributed within the 50-mile local area of the facility; these were 110 man-rem for the 300-ft stack and 63 man-rem for the 1000-ft stack. The results of these dose calculations suggest that a 1000-ft stack would be very effective in reducing the estimated doses. Plant growth carbon assimilation model was derived in order to investigate the adequacy of the assumption of tissue equilibration with time-averaged ambient specific activity as a basis for dose estimates. Simulation runs with these models suggest that in the presence of frequent fluctuations of large amplitude in the ambient air $^{14}CO_2$ concentrations, specific activity in plant tissue can exceed conventionally calculated time-averaged specific activity.

2544 (TID—27118) **Phase II, Title I engineering assessment of inactive uranium mill tailings, Vitro Site, Salt Lake City, Utah.** (Ford, Bacon and Davis Utah, Inc., Salt Lake City (USA)). 30 Apr 1976. Contract E(05-1)-1658. 295p. Dep. NTIS $9.25.

As a result of a preliminary survey (Phase I) completed in October 1974, ERDA identified some 18 sites in the states of Arizona, Colorado, Idaho, New Mexico, Oregon, Texas, Utah, and Wyoming for which practicable remedial measures are to be evaluated. Most of these mills produced by far the greatest part of their output of uranium under contracts with the U.S. Atomic Energy Commission during the period 1947 through 1970. After operations ceased some companies made no attempt to stabilize the tailings, while others did so with varying degrees of success. In recent years there has developed a growing concern about the possible adverse effects to the general public from long-term exposure to low-level sources of radiation. Much attention has been focused on the growing accumulation of wastes containing radium and thorium at uranium ore processing mills in the western United States. To date, the studies of radiation levels in the vicinity of these sites have been limited in scope. The factual data available were insufficient to permit an assessment of risk to people with any degree of confidence in the conclusions reached. In addition, information on practicable measures to reduce radiation exposures and estimates of their projected costs are completely lacking. The purpose of this study is to develop the necessary information to provide a basis for decision making for appropriate remedial action. This report is the first of a series to be made on inactive uranium mill sites in the western United States. The site of the former Vitro Chemical Company mill in Salt Lake City, Utah, was selected for the first study since it includes a large unstabilized mill tailings pile, is located in a major metropolitan area, and involves most of the problems expected to be encountered at other locations. The effort required to complete the engineering analysis of the remaining sites and to prepare reports is expected to require about a year.

2545 Uranium tailings in the public eye. Lyon, B. *Oak Ridge Natl. Lab. Rev.*; **9**: No. 3, 18-23(Sum 1976).

The ORNL field team visits to Grand Junction, Colorado, and to other sources of uranium mill tailings, are described. The radioactive hazards of these tailings, which are principally due to Th, Ra, Rn, and radon daughters, are discussed briefly. Government actions which were taken as a result of public concern are listed. The ORNL Health Physics Division mobile laboratory van and its use in assessing the tailings piles at Salt Lake City and elsewhere are described. The highest γ-ray background found was 155 mRem/y, with levels being as high as 1750 mRem/y near points of public access to piles. Some possible solutions to the problem are discussed. (DLC)

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 2527, 2545, 3131

2546 Safety and environment. Cogne, F. *Rev. Gen. Nucl.*; **1**: No. 3, 175-177(Jul 1975). (In French).

The author analyses the papers presented by C. Starr and M. Muntzing at the Paris Conference on the maturity of nuclear energy. The main problems raised in the matter of safety (safety of the plants, plutonium toxicity, the possibilities of theft or sabotage, treatment and storage of the waste) are analyzed and it is pointed out that the hazards arising from the use of nuclear power are contained within reasonable limits. The experts should take the initiative of informing the general public on these matters as the mass media circulate too much inaccurate information in this field. As concerns the environment, it is the choice of sites and the harmonizing of the rules and procedures which appear to be the most important problems for the authorities charged with safety measures.

2547 Evolution of particulate pollution in the confined atmosphere of a uranium mine. Lopez, A.; Fontan, J. (Toulouse-3 Univ., 31 (France)). *J. Aerosol Sci.*; **7**: No. 1, 63-80(Jan 1976). (In French).

A study of the different mechanisms which govern the evolution of particulate pollution in the atmosphere of a gallery of a uranium mine (deposition on the walls, coagulation) is presented. As a first step, the numerical coefficients which characterize the aerosol are determined from the air flow and the surface state of the walls. From these results a theoretical model is constructed and applied to a simplified type of mine gallery, a cylindrical duct with turbulent air flow. The results obtained with this model are compared with experimental values. In the second step, these results help to forecast the evolution of particulate pollution for different conditions of the mining environment. This work gives some ideas for research on methods of decreasing the particle concentration and the radioactive aerosol in the air of a uranium mine.

REGULATIONS

REFER ALSO TO CITATION(S) 3345

ACCOUNTABILITY AND SAFEGUARDS

REFER ALSO TO CITATION(S) 2546, 2701

2548 (LA-UR—76-1310) **Safeguards technology: present posture and future impact.** Keepin, G.R. (Los Alamos Scientific Lab., N.Mex. (USA)). 1976. Contract W-7405-eng-36. 35p. (CONF-761014—1). Dep. NTIS $4.00.

From 1. Pacific Basin topical conference on nuclear development and the fuel cycle; Honolulu, Hawaii, United States of America (USA) (11 Oct 1976).

With widespread and growing concern over the issues of nuclear safeguards, international nuclear trade and nuclear weapons proliferation, the full development of the world's nuclear

energy potential could well depend on how effectively the strategic nuclear materials that fuel nuclear power are controlled and safeguarded. The broad U.S. program in nuclear safeguards and security is directed toward a balanced safeguards system incorporating the two major components of physical security and materials control. The current posture of modern safeguards technology, its impact on plant operations, and the key role it must play in the implementation of stringent cost-effective safeguards systems in facilities throughout the nuclear fuel cycle are outlined.

2549 (UCRL—52000-76-7, pp 5-9) **Automated uranium assays.** Harrar, J.E. Jul 1976.

In Energy and technology review.

Precise, timely inventories of enriched uranium stocks are vital to help prevent the loss, theft, or diversion of this material for illicit use. A wet-chemistry analyzer has been developed at LLL to assist in these inventories by performing automated analyses of uranium samples from different stages in the nuclear fuel cycle. These assays offer improved accuracy, reduced costs, significant savings in manpower, and lower radiation exposure for personnel compared with present techniques.

2550 Determination and check of the NUKEM stock of nuclear materials in the framework of nuclear safeguards as specified in the verification agreement. Pilgenroether, A.; Schinzer, F. (Nuklear-Chemie und -Metallurgie G.m.b.H. (NUKEM), Hanau (F.R. Germany)); Bicking, U.; Brueckner, C.; Onnen, S. (Kernforschungszentrum Karlsruhe (F.R. Germany)). pp 443-445 of In Reactor conference, Duesseldorf, 30.3.-2.4.1976. Section 2: Fuel elements, fuel cycle and isotope technique. Eggenstein-Leopoldshafen, F.R. Germany; ZAED (1976). (In German)

From Reactor meeting; Duesseldorf, F.R. Germany (30 Mar 1976).

Short communication only.

2551 Quantification methodology for special nuclear materials (SNM) safeguards systems. Kendrick, H. (Science Applications, Inc., McLean, VA); Lofgren, E.; Rundquist, D. *Trans. Am. Nucl. Soc.*; **23**: 94-95(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2552 System for assay of fissile content of spent LMFBR fuel subassemblies. Ragan, G.L.; Booth, R.S.; Burns, T.J.; Jenkins, J.D.; Weisbin, C.R.; Williams, L.R. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.*; **23**: 95-96(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2553 Analysis of fissile materials by cyclic activation of delayed neutrons. Jamieson, J.M.; Eichholz, G.G. (Georgia Inst. of Tech., Atlanta). *Trans. Am. Nucl. Soc.*; **23**: 96(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

ADMINISTRATIVE AND REGULATORY

2554 (REG/G—5.57(6-76)) **Shipping and receiving control of special nuclear material.** (Nuclear Regulatory Commission, Washington, D.C. (USA). Office of Standards Development). Jun 1976. 8p. NUREG.

A compilation of practices currently in use in the shipping and receipt of special nuclear material, which are acceptable to the NRC, is presented. The organizational components of the shipper to insure physical protection of the SNM before and during shipment and the responsibilities of the receiver in verifying the receipt of the SNM are outlined. (JSR)

2555 (REG/G—10.3(7-76)) **Guide for the preparation of applications for special nuclear material licenses of less than critical mass quantities.** (Nuclear Regulatory Commission, Washington, D.C. (USA). Office of Standards Development). Jul 1976. 6p. NUREG.

This guide describes the type of information needed to evaluate an application for a specific license for receipt, possession, use, and transfer of special nuclear material. It is intended for applicants requesting authorization to possess and use up to 2,000 grams of plutonium, total, in the form of sealed plutonium—beryllium neutron sources, and any special nuclear material in quantities and forms not sufficient to form a critical mass. The latter quantities are considered to be 350 grams of contained uranium-235, 200 grams of uranium-233, 200 grams of plutonium (in any form other than plutonium—beryllium neutron sources) or any combination of them.

FUSION FUELS

BY-PRODUCTS

2556 (UCRL—52068) **Estimated heat capacity, enthalpy, thermal conductivity, and diffusivity of solid D-T.** Souers, P.C.; Tsugawa, R.T. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 4 May 1976. Contract W-7405-eng-48. 61p. Dep. NTIS $4.50.

A program conducted to estimate the physical properties of the thermonuclear fusion fuel, D-T (actually the mixture deuterium-deuterium tritide-tritium) is described. The literature is reviewed on the heat capacity and thermal conductivity of solid hydrogen, hydrogen deuteride, and deuterium. Discussions are included on heat capacity and its attendant enthalpy deals with the crystal lattice, rotational, and quadrupolar mechanisms. For thermal conductivity, phonon scattering at crystallite boundaries and self-collisions (Umklapp processes) that reduce the phonon mean free path are described. The effects of rotational energy in either reducing crystallite size or causing phonon scattering from quadrupolar sublevels are discussed. Thermal diffusivity is derived from these properties plus density. An estimate of all the properties for the solid D-T mixture is included. Thermal conductivity and diffusivity prove especially interesting because they may vary as much as five orders of magnitude as a function of temperature, rotational energy, and radiation damage.

ISOTOPE AND RADIATION SOURCE TECHNOLOGY

PHYSICAL ISOTOPE SEPARATION

REFER ALSO TO CITATION(S) 2454, 3386

2557 Tritium production in nuclear power plants. Gueben, M. (Intercom (Belgium)); Beguin, P. (Compagnie Generale d'Entreprises Electriques et Industrielles, S.A. (ELECTROBEL), Brussels (Belgium)). *J. Belge Radiol.*; **58**: No. 2, 121-128(1975). (In French).

Tritium production in PWR plants id discussed. Various production reactions are possible, and the most important among them are described. Tritium concentration in primary coolant depends, in a large part, on cladding metal characteristics: a comparison is made between leak rate for Zircaloy and for stainless steel. These tritiated effluent releases are looked at, and pessimistic expected values are compared to the prescribed limits, taking the Tihange plant as an example. Comparison is made between PWR, BWR, and fast neutrons plants. It is not possible to state that tritium concentration in primary coolant can be accurately foreseen, but one can say that direct releases from power plants are relatively small and that prescribed limits are easily enforced. For fuel reprocessing plants, it will probably be necessary to have tritium recovery.

2558 Photochemistry and isotope separation in formaldehyde. Baronavski, A.P.; Clark, J.H.; Haas, Y.; Houston, P.L.; Moore, C.B. (Univ. of California, Berkeley). pp 259-267 of In Laser spectroscopy. Haroche, S.; Pebay-Peyroula, J.C.; Haensch, T.W.; Harris, S.E. (eds.). New York; Springer-Verlag (1975).

From Conference on laser spectroscopy; Megeve, France (23 Jun 1975).

See CONF-7506103—.

Properties of the first excited singlet state of formaldehyde were studied with ultraviolet lasers and via two photon absorption with a visible laser. Carbon isotope shifts have been resolved in many vibronic bands. Measurements of single vibronic level lifetimes were made for H_2CO, D_2CO, and HDCO. The energy states and rates of formation of the dissociation product CO were studied following excitation of a single vibronic level. These results called into question the model of spontaneous predissociation of formaldehyde through internal conversion to dissociative vibrational levels of the ground singlet state. The original experiments on isotope separation of D from H have been followed by separation of ^{13}C from ^{12}C. (MHR)

2559 Laser isotope separation. Robinson, C.P. (Los Alamos Scientific Lab., NM). pp 275-295 of In Laser spectroscopy. Haroche, S.; Pebay-Peyroula, J.C.; Haensch, T.W.; Harris, S.E. (eds.). New York; Springer-Verlag (1975).

From Conference on laser spectroscopy; Megeve, France (23 Jun 1975).

See CONF-7506103—.

Experience at Los Alamos Scientific Laboratory in studying possible uses of lasers for isotope separation is reviewed. In particular, results are given showing sulfur data in SF_6. (MHR)

HEAVY WATER PRODUCTION

2560 **Developments in heavy-water processes.** Rae, H.K. (Chalk River Nuclear Labs., Ont.). *Trans. Am. Nucl. Soc.*; **23**: 65-66(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

RADIATION SOURCES

REFER ALSO TO CITATION(S) 3776

OTHER INDUSTRIAL USES

REFER ALSO TO CITATION(S) 2370, 3956, 3957, 3958, 3959, 3960, 3961

ISOTOPIC POWER SUPPLIES

REFER ALSO TO CITATION(S) 3639

2561 (COO—2147-14) **Materials testing and requirement for the ERDA nuclear-powered artificial heart. Technical progress report, July 15, 1975—May 30, 1976.** Andrade, J.D.; Hufferd, W.L.; Lyman, D.J. (Utah Univ., Salt Lake City (USA). Coll. of Engineering). 1976. Contract E(11-1)-2147. 62p. (UTEC—76-202). Dep. NTIS $4.50.

The two materials currently being used for the artificial heart fabrication are BIOMER and AVCOTHANE. BIOMER is a polyether urethane polymer. AVCOTHANE is a proprietary polyurethane/polydimethylsiloxane polymer blend. Research progress on the chemical degradation, mechanical strength, and blood compatibility is reported. (TFD)

2562 (COO—2208-8) **Acceleration experienced by thermal converter implanted in calves.** Koshino, I.; Sukalac, R.; Jacobs, G.; Kiraly, R.J.; Nose, Y. (Cleveland Clinic Foundation, Ohio (USA). Dept. of Artificial Organs). Feb 1976. Contract E(11-)-2208. 22p. Dep. NTIS $3.50.

The objective of this study was to determine acceleration levels experienced by the ERDA thermal converter unit implanted abdominally in a calf. A full-scale weighted mock-up of the thermal converter was fabricated containing a triaxial accelerometer. The mock-up was implanted in calf cadavers which were subjected to falls from an operating table. Highest acceleration recorded was 34 g. The mock-up was implanted in living animals and acceleration measurements made under various maneuvers including walking, standing from a laying position, walking up and down stairs, jumping, and falling from a standing position. Maximum acceleration recorded was 8 g and occurred in the falling maneuver.

2563 (MLM—2309) **Transpiration of helium and carbon monoxide through a multihundred watt, PICS filter.** Schaeffer, D.R. (Mound Lab., Miamisburg, Ohio (USA)). 30 Jul 1976. Contract E(33-1)-GEN-53. 8p. Dep. NTIS $3.50.

The transpiration of CO through the Multihundred Watt (MHW) filter can be described by Fick's first law or as a first order, reversible reaction. From Fick's first law, a "diffusion" coefficient of 7.8 x 10^{-4} cm.L/sec (L is the average path length through the filter) was determined. For the first order reversible reaction, a rate constant of 0.0058 hr^{-1} was obtained for both the forward and reverse reactions (they were assumed to be equal). This corresponds to a half-life of 120 hr. It was also concluded that the rate constants and thus the transpiration rates, which were determined for the test, are smaller than those expected in the IHS. The effect of increasing the number of filters, changing the volumes, and increasing the temperature, changes the rate constant of the transpiration into the PICS to roughly 0.074 hr^{-1} (t/sub $^1/_2$/ = 9.4 hr) and out of the PICS to 0.84 hr^{-1} (t/sub 1/2/ = 0.8 hr). Of the two suggested mechanisms for the generation of CO inside the IHS, the cyclic process requires a much larger rate of transpiration than the process requiring oxygen exchange of CO given off by the graphite. The data indicate that the cyclic process can provide the CO generation rates observed in the IHS gas taps if there is no delay in time for any other kinetic process involved in the formation of CO or CO_2. Since the cyclic process (which requires the fastest rate of transpiration) appears possible, this study does not indicate which reaction is occurring but concludes both are possible.

DESIGN AND FABRICATION

2564 (DPST—73-128-2) **Savannah River Laboratory monthly report: ^{238}Pu fuel form processes.** (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). Feb 1973. Contract AT(07-2)-1. 22p. Dep. NTIS $3.50.

The smaller particle size of direct-strike $^{238}PuO_2$ made in the plant probably results from more vigorous mixing during precipitation of the oxalate than that used in the laboratory. Laboratory tests show that vigorous agitation, both during precipitation and after calcination, reduces the apparent particle size. Two methods for chemically plating Ir on ceramic particles were demonstrated to be feasible. The coated particles could be hot pressed to form cermet bodies with a more or less continuous network of Ir as required for the Plutonia-Iridium Cermet (PIC) that is being developed at Los Alamos Scientific Laboratory as an advanced fuel form. Over 1600 g of ^{238}Pu scrap was charged into the scrap recovery line to bring the total processed to date to 5840 g.

2565 **Thermoelectric microgenerator.** Thomas, P.; Alais, M. (to Compagnie Industrielle des Telecommunications Cit-Alcatel). US Patent 3,969,149. 13 Jul 1976. Priority date 13 Sep 1972, France. 6p.

A very compact thermoelectric microgenerator providing a high output voltage (10 V) and having high efficiency is described. The generator is comprised of a great number of thermocouples arranged in rows connected together so as to form a continuous conductor of deposited thin layers on a thin insulating support. The cold and hot sources are fitting provided with low walls parallel to one another and orthogonal to the rows of thermocouples. The even junctions of the thermocouples are placed in the vicinity of the low walls of the cold source and the odd junctions are placed in the vicinity of the low walls of the hot source. Application is to implanted medical appliances.

HYDROGEN

PRODUCTION

THERMOCHEMICAL PROCESSES

REFER ALSO TO CITATION(S) 2954

2566 **Thermochemical production of hydrogen from water.** Bamberger, C.E.; Richardson, D.M. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.*; **23**: 105(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

COAL GASIFICATION

REFER ALSO TO CITATION(S) 2283, 2317, 3591

TRANSPORT

REFER ALSO TO CITATION(S) 3336

2567 (CEA-CONF—3111) **Cryopumps for hydrogen.** Boissin, J.C.; Coutant, J.; Fois, M. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee). 15 Oct 1973. 9p. (In French). (CONF-740679—5). INIS.

From Meeting on vacuum technology) cryogenic vacuum; Versailles, France (10 Jun 1974).

Hydrogen cryopumping using condensation at 4.2 and 2.7 K was experimentally studied. Two cryopumps were developed. The first one (500 mm of diameter) is intended for nondirected flux pumping. The second one is intended for creating high vacuum conditions around the hydrogen beam passing through it. The 10^{-9}-10^{-6} torr range was investigated with hydrogen flux from 10^{-2} to 3 torr.l.s^{-1} and condensed amounts up to 12 liters (normal pressure and temperature). The pumping velocity, recovery time, cryogenic fluid consumption were determined. Hydrogen was introduced at 300 K under the form of continuous flux or pulses for the first cryopump and a directed jet for the second one. The two-cryopump assembly was studied in view of creating ultra-high

vacuum conditions around a hydrogen jet. A 1.3 10^{-7} torr pressure was then obtained around a jet whose flux was 2 torr.l.s^{-1}.

INDUSTRIAL AND COMMERCIAL USE

REFER ALSO TO CITATION(S) 3336

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 3072

OTHER SYNTHETIC AND NATURAL FUELS

HYDROCARBON FUELS

REFER ALSO TO CITATION(S) 2277, 2285, 2317, 3591

2568 Vapor-pressure relations for 15 hydrocarbons. Osborn, A.G.; Douslin, D.R. *J. Chem. Eng. Data;* **19**: No. 2, 114-117(Apr 1974).

Experimental values of vapor pressure for 15 hydrocarbons are measured in the low-pressure range 0.1 to 25 mm Hg by means of the inclined-piston deadweight gage and in the range 71 to 2,025 mm Hg by means of comparative ebulliometers. Correlations of the present results with selected literature values are given in terms of Cox equations.

2569 Gasification of solid waste material to obtain high Btu product gas. Sieg, R.P.; White, R.J. (to Chevron Research Co.). US Patent 3,817,725. 18 Jun 1974. vp.

Chevron Research Co. combines waste solids gasification with methanation and recycling of a portion of the combustible effluent to the gasification zone to produce high Btu gas from solid waste materials, such as municipal garbage, industrial or agricultural wastes. Temperature in the gasification zone is controlled by adjusting the temperature and/or amount of methanated gases recycled to the gasification zone. The gasification reactions should be carried out in the gasification zone to generate the required hydrogen and carbon oxides. To reduce the amount of reversal of the methanation reaction when the recycled methanated gases are introduced into the gasification zone, these methanated gases should be introduced at about the middle of the reactor where the temperature is about 800° to 1200°F. The gases obtained from the gasification zone are cooled and cleansed by a water quench, which is partly recycled to the gasification zone to supply heat and reactive gases.

2570 Gasification of carbonaceous solids. Mallan, G.M.; Compton, L.E. (to Occidental Petroleum Corp.). US Patent 3,846,096. 5 Nov 1974. vp.

Occidental Petroleum Corp. provides an efficient, economical method of recycling municipal, industrial, and agricultural waste through conversion to SNG. The otherwise unusable organic portion of solid carbonaceous wastes is converted to gaseous hydrocarbons ($C_1^-{}_7$) by means of a low-cost, high-capacity, rapid pyrolysis process based on heating shredded organic waste materials in the absence of air in a novel heat-exchange system. Each ton of wet, as-received municipal refuse will produce over 1 million CF of 900 to 1100-Btu pipeline-quality gas. (Fuel Abstr.)

2571 Process for producing high-methane gas. Liebgott, H. (to Metallgesellschaft Aktiengesellschaft). US Patent Application B 521,985. 7 Nov 1974. Priority date 3 Jan 1972, German, Federal Republic of (F.R. Germany). vp.

A process is described for producing high-methane gas. It comprises: catalytically cracking liquid hydrocarbons with water vapor at elevated temperatures and pressures to produce a rich gas containing less than 15 percent hydrogen by volume; cooling the rich gas below its dew point to a temperature below 150°C thereby reducing the water vapor content thereof by condensation; separating condensed water from the rich gas; thereafter dividing the rich gas into two streams and feeding same to a hydrogenation zone containing two catalyst layers, and scrubbing the product gas leaving the hydrogenation zone to remove carbon dioxide.

ALCOHOL FUELS

REFER ALSO TO CITATION(S) 2327, 3359, 3360, 3446, 3448, 3449

2572 (PERC—0060-4) **Sulfur poisoning of catalysts. Quarterly progress report, 1 April—30 June 1976.** Isakson, W.E.; Wentrcek, P.R.; Wise, H.; Wood, B.J. (Stanford Research Inst., Menlo Park, Calif. (USA)). 1 Jul 1976. Contract E(36-2)-0060. 20p. Dep. NTIS $3.50.

Progress is reported on an experimental study of the poisoning of catalysts used in methanol synthesis by sulfur-containing gases (hydrogen sulfide, thiophene, carbonyl sulfide). The changes in catalyst surface composition when the catalyst was exposed to hydrogen sulfide were determined by Auger electron spectroscopy. Thiophene is less deleterious than hydrogen sulfide. Values of the poisoning rate constant with hydrogen sulfide as a feedstock contaminant are nearly identical for the LPP catalysts examined, but are about an order of magnitude smaller for HPP catalysts. The capture of hydrogen sulfide by the catalyst appears to be extremely efficient. (LTN)

2573 (TID/BERC—20) **Alternative fuels: methanol.** Hurn, R.W. (Bureau of Mines, Washington, D.C. (USA)). 1974. 10p. TIC.

Methanol is identified as a viable option for an alternative motor fuel for use in spark ignition engines. The material may be used either as straight methanol fuel or blended with gasoline. In either form of use, methanol offers possible advantage but only coupled with significant problems. Combustion characteristics may be improved, but materials compatibility and blend phase stability present serious difficulties. An experimental program to more comprehensively describe the physical and combustion characteristics of methanol and methanol/gasoline blends is described.

SOLID WASTE FUELS

2574 Method of extruding bark and of forming a solid synthetic fuel. Hartman, W.H.; Mietz, R.E.; Peschke, J.R.; Ruge, D.H. (to American Can Co.). US Patent 3,947,255. 10 Jan 1973. vp.

A method is described of forming a solid synthetic fuel comprised of from about 60 to 95 percent by weight bark, the method which comprises: drying pieces of bark of an extrudable size to a moisture content of less than 7 percent, physically blending pieces of combustible non-noxious non-odor-producing thermoplastic of an extrudable size with said dried pieces of bark to form a bark-thermoplastic mixture of from about 60 to 95 percent by weight bark and about 5 to 40 percent by weight thermoplastic, feeding the mixture to an extruder, heating the bark thermoplastic mixture in the extruder, controlling the heat of the extruder to range from about 250 to 400°F so that its temperature is insufficient to char the bark pieces yet sufficient to melt the thermoplastic and disperse it between the bark pieces so that it acts as a binder therefor and adheres sufficiently to the interior barrel wall surface of the extruder to allow the mixture to be moved therethrough by the extruder screw, extruding the mixture in the form of a composite extrudate, and cooling the composite extrudate to solidify it into the solid synthetic fuel.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 3872

SOLAR ENERGY

RESOURCES AND AVAILABILITY

REFER ALSO TO CITATION(S) 4034

2575 (NP—20828) **Solar radiation reception, probabilities, and areal distribution in the north-central region. Technical bulletin 300.** (Minnesota Univ., St. Paul (USA). Agricultrual Experiment Station). 1975. 53p.

The purpose of this bulletin is to provide information on the statistical, temporal, and spatial characteristics of the solar radiation received in the north-central region of the U. S. The solar radiation records of 20 stations in the north-central region were

analyzed with the aid of punched cards obtained from the National Weather Records Center of Asheville, North Carolina. (WDM)

2576 (SAND—76-0411) **Distribution of direct and total solar radiation availabilities for the USA.** Boes, E.C.; Hall, I.J.; Prairie, R.R.; Stromberg, R.P.; Anderson, H.E. (Sandia Labs., Albuquerque, N.Mex. (USA)). Aug 1976. Contract E(29-1)-789. 30p. (CONF-760821—12). Dep. NTIS $4.00.

From Sharing the sun, solar technology in the seventies; Winnipeg, Canada (15 Aug 1976).

The only long-term US solar radiation data base with reasonable geographic coverage is the total-horizontal data recorded by the National Weather Service. Since most solar collectors will not be horizontal, designers will need to know the availabilities of solar radiation to different types of both flat-plate and concentrating collectors in various orientations. A project to determine the geographic distributions of these availabilities by month on a mean daily basis is in progress. The data base consists of hourly total-horizontal readings for 26 US locations for the years 1958 to 1962. This paper presents maps and tables showing the availability of direct-normal radiation by month for the US. The results indicate that there is more direct solar energy than has been generally believed; direct-normal radiation availability generally exceeds total-horizontal availability by about 60 percent in the winter. Availabilities to other surfaces will be described in the final report to be published at the conclusion of this project.

2577 **Insolation on south facing tilted surfaces: Pacific Northwest locations.** Baker, M.S.; Reynolds, J.S. Eugene, OR; University of Oregon (1975). 57p. (NP—21124).

The results point out (1) the variability of the incident radiation over the Northwest in both time and space, (2) the magnitude of the direct component even during our cloudy winter months, (3) the relative insensitivity of incident radiation to receiving surface slope (the penalty for non-optimal orientation is not large), and (4) the optimal orientation for total radiation (non-focusing applications) and direct radiation (focusing applications).

SOLAR ENERGY CONVERSION

PHOTOVOLTAIC CONVERSION

REFER ALSO TO CITATION(S) 2627

2578 (BMFT-FB-W—75-14) **Development of large-area thin silicon solar cells.** Fischer, H.; Pschunder, W. (Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.); Zentralstelle fuer Luft- und Raumfahrtdokumentation und -information, Muenchen (Germany, F.R.)). Sep 1975. 121p. (In German). INIS.

65 figs.; 2 tabs.; 15 refs. Available from ZLDI.

The present investigations deal with the development of economic processes for fabricating large area, thin silicon solar cells. The influence of various methods on the electrical and mechanical properties has been thoroughly investigated. For specific applications, such as flexible solar generators, new contact geometries are innovated. A simple solution is presented for the fabrication of a p^+-backside contact. Electrical data and environmental test data of large area cells per unit area are comparable to those of standard cells. For the present state-of-the-art 2 x 4 cm cells with approximately 200 μm thickness seem to be the most economical ones.

2579 (CONF-760131—) **Proceedings of the second ERDA semiannual Solar Photovoltaic Conversion Program review, Lake Buena Vista, Florida, January 20—23, 1976.** (Energy Research and Development Administration, Washington, D.C. (USA). Div. of Solar Energy). 1976. 707p. Dep. NTIS $18.75.

From Proceedings of the second ERDA semiannual Solar Photovoltaic Conversion Program review; Lake Buena Vista, Florida, United States of America (USA) (20 Jan 1976).

This report of the proceedings of the meeting was prepared to provide the participants and other interested parties with a compilation of abstracts of the talks given. Copies of visual aids used have been printed in the best available form. Separate abstracts were prepared for the individual presentations. (WDM)

2580 (CONF-760131—, pp 3-5) **National photovoltaic plan.** Prince, M.B. 1976.

From Proceedings of the second ERDA semiannual Solar Photovoltaic Conversion Program review; Lake Buena Vista, Florida, United States of America (USA) (20 Jan 1976).

In Proceedings of the second ERDA semiannual Solar Photovoltaic Conversion Program review.

The following three items are reviewed: (1) the objectives of the photovoltaic program; (2) the present organization of the program; and (3) the ERDA budgets for the program. (WDM)

2581 (CONF-760131—, pp 11-15) **Polycrystalline silicon solar cells: an overview.** Warschauer, D.M. 1976.

From Proceedings of the second ERDA semiannual Solar Photovoltaic Conversion Program review; Lake Buena Vista, Florida, United States of America (USA) (20 Jan 1976).

In Proceedings of the second ERDA semiannual Solar Photovoltaic Conversion Program review.

A very brief overview is given on the goals of the National Photovoltaic Program. (WDM)

2582 (CONF-760131—, pp 19-32) **Mission analysis of photovoltaic solar energy systems.** Leonard, S.L. (Aerospace Corp., Los Angeles). 1976.

From Proceedings of the second ERDA semiannual Solar Photovoltaic Conversion Program review; Lake Buena Vista, Florida, United States of America (USA) (20 Jan 1976).

In Proceedings of the second ERDA semiannual Solar Photovoltaic Conversion Program review.

The goals of this study will be devoted to five tasks. The first of these (Task 1) will be a comprehensive survey and evaluation of near-term (1976-1985) photovoltaic applications, leading to the identification of those most likely to contribute significantly to the orderly growth of the overall market for photovoltaic arrays. In Task 2 the two or three major missions (i.e., those representing potentially very large markets) having the greatest market capture potential in the mid-term (1985-2000) time period will be identified. Under Task 3, the technology implementation plan that is implicit in ERDA's projection of the growth of the photovoltaic market will be reviewed and updated to take into account the impact of markets identified in Tasks 1 and 2. Under Task 4 detailed analyses will be made of critical external issues that are likely to affect the future market for photovoltaic arrays. In Task 5 an evaluation will be made of the potential impact on the photovoltaic market of government incentives. In Task 6 an analysis will be made of the total cost to society of the production of electric power by conventional fossil-fuel and nuclear generating plants and by photovoltaic plants. (WDM)

2583 (CONF-760131—, pp 33-54) **Developing country applications of photovoltaic cells.** Weiss, C.; Pak, S. 1976.

From Proceedings of the second ERDA semiannual Solar Photovoltaic Conversion Program review; Lake Buena Vista, Florida, United States of America (USA) (20 Jan 1976).

In Proceedings of the second ERDA semiannual Solar Photovoltaic Conversion Program review.

The increased emphasis on rural development in developing countries will mean increased demand for small-scale sources of energy, since most rural areas in developing countries will not be reached soon by an electric grid. For example, small-scale energy sources are needed to power educational TV sets, refrigerators for clinics, and small appliances for tourist centers in remote areas. Solar cells cost more initially than does the equipment now in widespread use for such applications—chiefly primary cells and gasoline generators—but in many cases will be cheaper in the long run. The potential market for solar cells to meet these needs in developing countries (not just oil exporters) is a reasonable fraction of the ERDA targets for U.S. production of solar cells, at least until such cells become competitive with large-scale technology for generating electricity. Potential buyers are likely to insist on long-term performance guarantees, and on compatibility with environmental extremes.

2584 (CONF-760131—, pp 57-88) **Photovoltaic systems definition project of the ERDA National Solar Photovoltaic Program.** Schueler, D.G.; Marshall, B.W. 1976.

From Proceedings of the second ERDA semiannual Solar Photovoltaic Conversion Program review; Lake Buena Vista, Florida, United States of America (USA) (20 Jan 1976).

In Proceedings of the second ERDA semiannual Solar Photovoltaic Conversion Program review.

The ERDA Photovoltaic Branch has structured the National Solar Photovoltaic Program into several interrelated projects which address major segments of the overall program. The responsibility to conduct the Systems Definition Project has recently been assigned to Sandia Laboratory. This project is concerned with developing conceptual system designs, evolving preferred system configurations, identifying subsystem performance and technology requirements, and providing detailed system designs and specifications for a wide range of photovoltaic applications having potential national significance. Information developed through this project will provide systems-related guidance to the other projects of the program as well as input for future program planning. (WDM)

2585 (CONF-760131—, pp 89-100) **Investigation of terrestrial photovoltaic power systems with sunlight concentration.** Backus, C.E. (Arizona State Univ., Tempe); Castle, J.A. 1976.

From Proceedings of the second ERDA semiannual Solar Photovoltaic Conversion Program review; Lake Buena Vista, Florida, United States of America (USA) (20 Jan 1976).

In Proceedings of the second ERDA semiannual Solar Photovoltaic Conversion Program review.

The second year of a joint investigation between Arizona State University and Spectrolab, Inc. has been completed. The first year of the study was analytical in nature. The second year was to experimentally investigate the validity of the encouraging results of the first year's study and has resulted in preliminary verification of the early conclusions. (WDM)

2586 (CONF-760131—, pp 103-198) **Low Cost Silicon Solar Array Project.** Forney, R.G. (Jet Propulsion Lab., Pasadena, CA). 1976.

From Proceedings of the second ERDA semiannual Solar Photovoltaic Conversion Program review; Lake Buena Vista, Florida, United States of America (USA) (20 Jan 1976).

In Proceedings of the second ERDA semiannual Solar Photovoltaic Conversion Program review.

The responsibility to conduct ERDA's Low-cost Silicon Solar Array Project, which is a part of the overall Solar Photovoltaics Program, has been delegated to the Jet Propulsion Laboratory (JPL). The objectives of the Project include a 1985 goal to reduce silicon solar array prices to less than $500/KW. These low-cost arrays further shall have lifetimes greater than 20 years, conversion efficiencies greater than 10 percent, and a national rate of units manufactured greater than 500 MW per year. There are five major Task areas: Silicon Material, Large Area Silicon Sheet, Module Encapsulation, Automated Array, and Large Scale Production. (WDM)

2587 (CONF-760131—, pp 201-204) **Progress and plans for the ERDA Test and Demonstration Project.** Deyo, J.N. (Lewis Research Center, Cleveland). 1976.

From Proceedings of the second ERDA semiannual Solar Photovoltaic Conversion Program review; Lake Buena Vista, Florida, United States of America (USA) (20 Jan 1976).

In Proceedings of the second ERDA semiannual Solar Photovoltaic Conversion Program review.

The Test and Demonstration Project is one of several interrelated projects making up the ERDA National Photovoltaic Conversion Program. Objectives of the Test and Demonstration Project are to conduct tests, demonstrations, and evaluations of photovoltaic systems and subsystems in applications having national significance. Experience and information gained through this project will be used to evaluate emerging systems technology, provide systems-related guidance to the other projects of the national program, and develop information for future photovoltaic program planning. (WDM)

2588 (CONF-760131—, pp 205-217) **Summary of the NASA space photovoltaic research and technology program.** Brandhorst, H.W. Jr. (Lewis Research Center, Cleveland). 1976.

From Proceedings of the second ERDA semiannual Solar Photovoltaic Conversion Program review; Lake Buena Vista, Florida, United States of America (USA) (20 Jan 1976).

In Proceedings of the second ERDA semiannual Solar Photovoltaic Conversion Program review.

The NASA Lewis Research Center research and technology program for space photovoltaic cells has as its objective the development of low cost solar cells and arrays with high end-of-life efficiency. The low cost comes through two approaches: one, to obtain increased device efficiency at no increase in cost and two, to reduce the manufacturing costs of space solar cells and arrays. (WDM)

2589 (CONF-760131—, pp 219-233) **Military Applications of Photovoltaic Systems. Program status report, 1 November 1975—30 September 1976.** Faehn, D.D. (Army Mobility Equipment Research and Development Center, Fort Belvoir, VA). 1976.

From Proceedings of the second ERDA semiannual Solar Photovoltaic Conversion Program review; Lake Buena Vista, Florida, United States of America (USA) (20 Jan 1976).

In Proceedings of the second ERDA semiannual Solar Photovoltaic Conversion Program review.

The principal objective of the MAPS program is to investigate the applicability of solar photovoltaic energy conversion systems to a wide variety of military power consuming equipment. This is to be accomplished by a comprehensive demonstration program, involving six DOD systems with a total array peak power rating of approximately 90 KW. (WDM)

2590 (CONF-760131—, pp 237-254) **Development of low cost thin film polycrystalline silicon solar cells for terrestrial applications.** Chu, T.L. (Southern Methodist Univ., Dallas). 1976.

From Proceedings of the second ERDA semiannual Solar Photovoltaic Conversion Program review; Lake Buena Vista, Florida, United States of America (USA) (20 Jan 1976).

In Proceedings of the second ERDA semiannual Solar Photovoltaic Conversion Program review.

The objective of this grant is to develop low-cost polycrystalline silicon solar cells for terrestrial utilization. The formation of p-n junction structures on low-cost substrates has been used as the principal approach to fulfill the objective. (WDM)

2591 (CONF-760131—, pp 255-270) **Epitaxial silicon technology for low-cost solar cells.** Kressel, H. (RCA Labs., Princeton, NJ); D'Aiello, R.; Robinson, P.; McFarlane, S.H.; Raccah, P.M.; Pollak, F.H. 1976.

From Proceedings of the second ERDA semiannual Solar Photovoltaic Conversion Program review; Lake Buena Vista, Florida, United States of America (USA) (20 Jan 1976).

In Proceedings of the second ERDA semiannual Solar Photovoltaic Conversion Program review.

The objective of this program is to demonstrate a means of generally improving the quality of the devices obtained by the use of thin epitaxial layers deposited on such material. The program encompasses analytical studies aimed at relating the defects to device performance, and the fabrication of solar cells on a comparative basis (diffusion vs. epitaxial growth on crystals of similar quality) to establish the improvement which is obtained. (WDM)

2592 (CONF-760131—, pp 271-285) **Advanced Silicon Solar Cell Process Program.** Wichner, R. (Univ. of California, Livermore). 1976.

From Proceedings of the second ERDA semiannual Solar Photovoltaic Conversion Program review; Lake Buena Vista, Florida, United States of America (USA) (20 Jan 1976).

In Proceedings of the second ERDA semiannual Solar Photovoltaic Conversion Program review.

The objective of this program is to develop low cost techniques applicable to the automated production of high efficiency silicon solar cells, utilizing low temperature processing steps for use with both single crystal and defect-laden (ribbon or thin film polycrystalline) solar cell substrate material. It is shown that the corona discharge process is capable of producing efficient p-n junctions. (WDM)

2593 (CONF-760131—, pp 287-296) **Silicon thin film crystallization and solar cell fabrication.** Kirkpatrick, A.R.; Little, R.G. (Simulation Physics, Inc., Burlington, MA). 1976.

From Proceedings of the second ERDA semiannual Solar Photovoltaic Conversion Program review; Lake Buena Vista, Florida, United States of America (USA) (20 Jan 1976).

In Proceedings of the second ERDA semiannual Solar Photovoltaic Conversion Program review.

Approaches to fabrication of thin film silicon solar cells on large area glass sheet substrates are examined. The program involves a study of recrystallization techniques for silicon films, investigation of effective methods for low cost, and effective utilization of recrystallized films in a solar cell structure.

2594 (CONF-760131—, pp 299-320) **Very low cost thin film CdS—Cu/sub x/S solar cell development by chemical spraying.** Jordan, J.F. (D.H. Baldwin Co., Dallas); Samara, G.A. 1976.

From Proceedings of the second ERDA semiannual Solar Photovoltaic Conversion Program review; Lake Buena Vista, Florida, United States of America (USA) (20 Jan 1976).

In Proceedings of the second ERDA semiannual Solar Photovoltaic Conversion Program review.

Work on CdS—Cu/sub x/S solar cells is described. An increase in maximum efficiency to 5.2 percent from 4.82 percent previously reported has been attained with an increase in average efficiency. Data have been obtained on the carrier densities in the CdS and specific resistivity normal to the film measured by two methods, the more accurate being that of Sandia. The latter is done by means of an electrode pattern. (WDM)

2595 (CONF-760131—, pp 321-342) **Research directed to stable high efficiency CdS solar cells.** Meakin, J.D. (Univ. of Delaware, Newark). 1976.

From Proceedings of the second ERDA semiannual Solar Photovoltaic Conversion Program review; Lake Buena Vista, Florida, United States of America (USA) (20 Jan 1976).

In Proceedings of the second ERDA semiannual Solar Photovoltaic Conversion Program review.

Objectives of this program are to establish the maximum achievable conversion efficiency and quantify the degradation modes of a thin film polycrystalline cell based on the CdS/Cu_xS junction. (WDM)

2596 (CONF-760131—, pp 343-366) **Feasibility of Cu_2S/CdS thin film solar cells for large scale power generation.** Shirland, F.A. (Westinghouse Research Labs., Pittsburgh). 1976.

From Proceedings of the second ERDA semiannual Solar Photovoltaic Conversion Program review; Lake Buena Vista, Florida, United States of America (USA) (20 Jan 1976).

In Proceedings of the second ERDA semiannual Solar Photovoltaic Conversion Program review.

The feasibility of the Cu_2S/CdS thin film solar cell for large scale low cost solar energy conversion has essentially been demonstrated. Specific recommendations are made for expanded research, development, and engineering efforts in order to accelerate progress to meet the national goals. (WDM)

2597 (CONF-760131—, pp 367-379) **Reactively sputtered thin film photovoltaic devices.** Hsieh, E.J. (Univ. of California, Livermore). 1976.

From Proceedings of the second ERDA semiannual Solar Photovoltaic Conversion Program review; Lake Buena Vista, Florida, United States of America (USA) (20 Jan 1976).

In Proceedings of the second ERDA semiannual Solar Photovoltaic Conversion Program review.

The project goal is to apply multiple sputtering techniques to form low cost, high performance thin film photovoltaic devices from materials used in existing single and polycrystalline solar cells. The immediate objective is to develop a stable, high efficiency thin film CdS—Cu_2S cell by reactive sputtering techniques.

2598 (CONF-760131—, pp 381-401) **Applied research on II—VI compound materials for heterojunction solar cells.** Bube, R.H. (Stanford Univ., CA). 1976.

From Proceedings of the second ERDA semiannual Solar Photovoltaic Conversion Program review; Lake Buena Vista, Florida, United States of America (USA) (20 Jan 1976).

In Proceedings of the second ERDA semiannual Solar Photovoltaic Conversion Program review.

The objective of this grant is the preparation and investigation of heterojunction solar cells based on several II-VI compound systems suitable for large-scale terrestrial application. (WDM)

2599 (CONF-760131—, pp 403-428) **Investigation of thin film solar cells based on Cu_2S and certain ternary compounds. Status report, July 1, 1973—June 30, 1976.** Loferski, J.J. (Brown Univ., Providence). 1976.

From Proceedings of the second ERDA semiannual Solar Photovoltaic Conversion Program review; Lake Buena Vista, Florida, United States of America (USA) (20 Jan 1976).

In Proceedings of the second ERDA semiannual Solar Photovoltaic Conversion Program review.

This research program has as its goal the fabrication of thin film solar cells based on Cu/sub x/S and certain ternary semiconductors, especially $CuInS_2$ which has very attractive characteristics for thin film photovoltaic cell application but including $CuAlS_2$, etc. Sulfurization of thin films of metal (Cu) and metal alloys (CuIn and CuAl) was proposed as the fabrication method. (WDM)

2600 (ERDA/JPL/954363—76/1) **Phase I of the Automated Array Assembly Task of the Low Cost Silicon Solar Array Project. Motorola report No. 2258/1. Technical quarterly report No. 1.** Coleman, M. (Motorola, Inc., Phoenix, Ariz. (USA). Semiconductor Group). Apr 1976. 50p. Dep. NTIS $4.00.

Phase I of the Automated Array Assembly Task, LCSSAP, is concerned with a comprehensive assessment of the improvements in existing technology that may be needed in order to develop, by 1985, an industrial capability for low cost, mass production of very durable silicon solar photovoltaic modules and arrays. Design criteria for efficient solar cells are discussed, emphasis being given to front metal surface pattern and texture etched front surfaces. A generalized processing matrix, containing competing methods for solar cell manufacturing steps, is outlined. The steps in this processing matrix are discussed and characterized according to immediate and potential usefulness. Representative steps have been chosen for empirical evaluation.

2601 (ERDA/JPL/954372—76/2) **Chemical vapor deposition growth. Quarterly report No. 2.** Ruth, R.P.; Manasevit, H.M.; Kenty, J.L.; Mondy, L.A.; Simpson, W.I.; Yang, J.J. (Rockwell International Corp., Anaheim, Calif. (USA). Electronics Research Div.). 1 Jul 1976. Contract NAS(7-100)-954372. 99p. Dep. NTIS $5.00.

The objective of the program is the development of CVD techniques for producing large areas of Si sheet on inexpensive substrate materials, with sheet properties suitable for fabricating solar cells meeting the technical goals of the Low Cost Silicon Solar Array Project (LCSSAP). The techniques developed are to be directed toward (1) minimum-cost processing, (2) production of sheet having properties adequate to result in cells with terrestrial array efficiency of 10 percent or more, and (3) eventual scale-up to large-quantity production. (WDM)

2602 (ERDA/JPL/954373—76/3) **Heat exchanger-ingot casting/slicing process. Silicon sheet growth development for the large area silicon sheet task of the low cost Silicon Solar Array Project. Third quarterly progress report, April 1, 1976—June 18, 1976.** Schmid, F.; Reynolds, B. (Crystal Systems, Inc., Salem, Mass. (USA)). 21 Jun 1976. Contract 954373. 41p. Dep. NTIS $4.00.

The object of this program is to demonstrate that large single-crystal ingots, 6-inch diameter by 4 inches tall, can be economically cast by the Heat Exchanger Method (HEM) and economically sliced into thin sheets, 0.008-inches thick, with a multi-wafer slicer. The thrust of the experimental work during this quarter was to establish the proper seed meltback and to nucleate single-crystal growth off the seed. Slicing tests were begun on the multi-blade wafering machine, using a newly fabricated sensitive feed mechanism and associated components. (WDM)

2603 (SAND—76-5759) **Photovoltaic energy conversion using concentrated sunlight.** Burgess, E.L. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1976. Contract E(29-1)-789. 7p. (CONF-760832—5). Dep. NTIS $3.50.

From 20. annual SPIE technical symposium; San Diego, California, United States of America (USA) (23 Aug 1976).

A development program is described which uses sunlight concentration techniques to effect an immediate reduction in cost-per-unit-power for photovoltaic systems in which solar cell cost dominates the total system cost. Current examples of concentrator solar cell technologies are single crystal silicon and gallium arsenide. Implementation of cost reductions by the use of sunlight concentration is not dependent on the development of low-cost, mass-production cell technologies but emphasizes high cell efficiency and low-cost concentrator systems.

2604 **Solar cells in the Trinity House Lighthouse service.** Richards, E.R. (Research Group, London). pp 617-635 of In Power sources 5. Collins, D.H. (ed.). New York; Academic Press Inc. (1975).

From 9. international power sources symposium; Brighton, UK (17 Sep 1974).

See CONF-740908—.

Investigations have taken place into the suitability of solar cells as a means of generating electrical energy for small remote loads such as low power navigation lights. Information is given on the results obtained from a number of solar cell test banks which have been set up. An experimental installation was planned and installed on the River Thames, and the results discussed. Corrosion within the solar cell modules has been a problem in the maritime applications, and this is dealt with in the paper. The problems of energy storage are also discussed.

PHOTOSYNTHETIC CONVERSION

2605 **Photosynthesis as a resource for energy and materials.** Calvin, M. (Univ. of California, Berkeley). *Am. Sci.*; **64**: No. 3, 270-278(1976).

The natural photosynthetic quantum-capturing mechanism of some plants may provide a design for a synthetic system that will serve as a renewable resource for material and fuel. (WDM)

PHOTOVOLTAIC POWER PLANTS

REFER ALSO TO CITATION(S) 2585

SOLAR THERMAL POWER PLANTS

TOWER FOCUS POWER PLANTS

2606 (NSF/RANN/SE/GI—39456/FR/75/3) **Solar thermal power systems based on optical transmission (a feasibility study). Final report, June 15, 1973—September 30, 1975.** Vant-Hull, L.; Easton, C.R. (Houston Univ., Tex. (USA). Solar Energy Lab.; McDonnell Douglas Astronautics West, Huntington Beach, Calif. (USA)). 21 Oct 1975. 420p. Dep. NTIS $11.00.

The objective of this project is to perform a preliminary technical and economic feasibility study of a solar thermal power system based upon optical transmission of collected solar energy to a central absorber and boiler unit. The study includes system definition, modeling, and preliminary component design and testing. Tasks to be completed include studies of (1) the solar flux concentration system, including system geometric analysis of the optical characteristics, guidance and control systems studies, and reflector designs; (2) the receiver and energy transfer system in-

cluding conceptual designs of the tower; (3) system definition and evaluation with particular attention to economic analysis of the collection, energy transfer, and energy conversion system; and (4) a scale model heliostat with electric motor steering.

2607 (SAN—1111-76-2) **Central receiver solar thermal power system. Collector subsystem, research experiments quarterly technical progress report.** (Boeing Co., Seattle, Wash. (USA)). 20 Apr 1976. Contract E(04-3)-1111. 92p. Dep. NTIS $5.00.

This document contains a description of the detail design (DD) of research experiment hardware to support the 10 MW/sub e/ Pilot Plant preliminary design (PD). Additionally, test plans for assembly, integration, and array tests are summarized along with results of completed component/material tests. Research experiment DD and tests described herein were planned to provide design verification and supporting data, with hardware which either duplicates, or closely simulates the Pilot Plant PD baseline.

2608 (SAN/1111—75/1) **Central receiver solar thermal power system, collector subsystem. Quarterly technical progress report.** (Boeing Engineering and Construction, Seattle, Wash. (USA).). 31 Dec 1975. Contract E(04-3)-1111. 90p. Dep. NTIS $5.00.

This document contains a description of the preliminary design baseline collector subsystem for a 10 MW/sub e/ solar thermal Pilot Plant. Also included are supporting data and analyses used in selecting the specific design, and results of research experiments in progress to verify the design. Each reflector in the collector subsystem is enclosed within a 7 meter (23 ft.) diameter, air-supported Tedlar dome. Tedlar for the baseline dome will be 0.15 mm (6 mils) thick and will be specially processed to obtain a smooth surface which will provide high specular (direct) transmittance (86 to 90 percent). The reflector utilizes a commercially-available 0.05 mm (2 mils) thick Mylar film which is coated with vacuum-deposited aluminum on one surface. The drive and control system selected for the heliostats is a computer-controlled open-loop system utilizing incremental position feedback from optical encoders on each heliostat drive. (WDM)

OCEAN THERMAL GRADIENT POWER PLANTS

2609 (CONF-760906—20) **Energy transmission from ocean thermal energy conversion plants.** Konopka, A.; Talib, A.; Yudow, B.; Biederman, N. (Institute of Gas Technology, Chicago, Ill. (USA)). 1976. Contract E(49-18)-2426. 10p. Dep. NTIS $3.50.

From 11. intersociety energy conversion engineering conference; State Line, Nevada, United States of America (USA) (12 Sep 1976).

This paper compares the transmission, by barge and pipeline, of gaseous hydrogen, liquid hydrogen, and ammonia, as energy carriers, with transmission of electricity in submarine cables from an OTEC plant. Because hydrogen energy and electrical energy are not equivalent, comparison requires assuming the outputs are converted to a common form. Thus, we present the delivered cost and overall energy efficiency of hydrogen, ammonia, and electricity as well as a discussion of the equipment, costs and efficiencies of converting hydrogen and ammonia into electricity, and OTEC mechanical energy into hydrogen and ammonia. Converting electricity to chemical commodities and energies was not assessed.

SOLAR RADIATION UTILIZATION

SPACE HEATING AND AIR CONDITIONING

2610 (CONF-750712—16) **Atypical Mathew solar house at Coos Bay, Oregon.** Reynolds, J.S.; Larson, M.B.; Baker, M.S.; Mathew, H.; Gray, R.L. (Oregon Univ., Eugene (USA)). 1975. 32p. Univ. of Oregon, Eugene. Center for Environmental Research.

From Annual meeting of the International Solar Energy Society; Los Angeles, California, USA (28 Jul 1975).

The purpose of this research was to determine the extent to which solar energy met the space heating needs of the Mathew House in Coos Bay, Oregon in the 1974-75 heating season (September through April). To this end, a detailed analysis was made of the monthly contributions made by various energy sources: electric lights and appliances, sun through windows, people, and electric space heating. These were compared with measured amounts of energy absorbed by the collector.

2611 (CONF-750712—17) **Enhanced solar energy collection using reflector-solar thermal collector combinations.** McDaniels, D.K.; Lowndes, D.H.; Mathew, H.; Reynolds, J.; Gray, R. (Oregon Univ., Eugene (USA)). 1975. 36p. Univ. of Oregon, Eugene. Center for Environmental Research.

From Annual meeting of the International Solar Energy Society; Los Angeles, California, USA (28 Jul 1975).

The amount of direct light gathered by a combination of reflector plus flat-plate collector has been analyzed. The calculations were done allowing variable reflector and collector orientation angles, variable latitude, and arbitrary sun hour angle away from solar noon. It was found that the optimum orientation has the collector plane almost perpendicular to the plane of the reflector. This optimum orientation is approximately independent of the sun's azimuthal dependence. The optimum reflector angle is found to be between 0—10° above the horizon for winter solar conditions. For typical winter operating conditions the enhancement in light gathering power for direct solar radiation is about a factor of 1.4 to 1.7. This results in an effective increase of 100 percent in the useful winter heat output from a practical reflector-collector combination with a reflector angle of 0°, over the useful heat output obtained with an optimally oriented simple flat-plate collector. An approximate calculation was also made of the overall enhancement in useful heat output for diffuse solar radiation; an increase by a factor of about 1.5 is predicted.

2612 (CONF-750712—18) **Preliminary performance of CSU Solar House I heating and cooling system.** Ward, D.S.; Weiss, T.A.; Loef, G.O.G. (Colorado State Univ., Fort Collins (USA). Solar Energy Applications Lab.). 1975. Contract E(11-1)-2577. 21p. Dep. NTIS $3.50.

From Annual meeting of the International Solar Energy Society; Los Angeles, California, USA (28 Jul 1975).

The NSF/CSU Solar House I heating and cooling system became operational on 1 July 1974. During the first months of operation the emphasis was placed on adjustment, "tuning", and fault correction in the solar collection and the solar/fuel/cooling subsystems. Following this initial check-out period, analysis and testing of the system utilizing a full year of data was begun. This paper discusses the preliminary performance of the heating and cooling system. (WDM)

2613 (CONF-750712—19) **Operational modes of solar heating and cooling systems.** Ward, D.S.; Smith, C.C.; Ward, J.C. (Colorado State Univ., Fort Collins (USA). Solar Energy Applications Lab.). 1975. Contract E(11-1)-2577. 23p. Dep. NTIS $3.50.

From Annual meeting of the International Solar Energy Society; Los Angeles, California, USA (28 Jul 1975).

This paper emphasizes factors associated with the subsystems that are required to extract heat from solar collectors, store this heat, and deliver it to the loads upon demand. While minimum use of auxiliary energy is the general objective, it must be sought with due regard to safety, convenience, and cost. Subsystem alterations that improve energy efficiency typically come at added cost in terms of installation and maintenance. In some cases, the advantages of a specified component or arrangement of components are immediately evident. In other cases, such options are less decisive and will require longer periods of comparative operation to arrive at accurate assessments. The Colorado State University Solar House I allows for such comparative operation in several experimental modes. These selected modes of operation provide for different methods of solar heat transfer and employ different arrangements of system components and control functions. The principles underlying these modes as well as results of these studies are presented. In addition, the methods of operation found necessary for efficient and reliable performance are discussed.

2614 (COO/2626—76/T1) **Solar heating experiment on the Grover Cleveland School, Boston, Massachusetts. Annual report.** (General Electric Co., Philadelphia, Pa. (USA). Space Div.). 15 Jul 1975. Contract E(11-1)-2626. 156p. Dep. NTIS $6.75.

This report presents quantitative and qualitative data obtained during the first full year's operation of an industrial type, solar heating system of pilot plant scale. A brief description of the system is given and operational data for the system is provided along with information on maintenance history, various relevant experiences, individual investigations and experiments, and problem areas which were experienced. (WDM)

2615 (NP—21125) **Energy conservation and solar retrofitting for existing buildings in Oregon.** Kemple, K. (ed.). (Oregon Univ., Eugene (USA)). Apr 1976. 127p. Univ. of Oregon, Eugene.

Basic principles are given of conservation in existing homes as a response to local climatic opportunities, re-evaluated assumptions of comfort, general domestic habits, architectural response, and the resulting energy use. Some principles of solar collection, storage, and thermal control are enumerated. Descriptions are given for several houses, their owners, their existing comfort requirements, energy needs, and a range of architectural and

domestic lifestyle alternatives for energy conservation and solar retrofitting. (WDM)

2616 (UMD—4908-6) **CCMS solar energy pilot study. Solar heating and cooling systems in buildings. Report to the CCMS Spring 1976 plenary, Brussels, Belgium, April 27—28, 1976.** (Maryland Univ., College Park (USA). CCMS Projects Office). 1976. Contract AT(40-1)-4908. 9p. (CONF-760483—1). Dep. NTIS $3.50.

From Committee on the challenges of modern society solar energy pilot study conference; Brussels, Belgium (27 Apr 1976).

The report to the 1976 CCMS spring plenary consisted of the text of the Pilot Study Directors Presentation and a report of the 1975 Palo Alto meeting. The agenda for the 1976 meeting in Copenhagen is given. (WDM)

2617 **Solar promise with heat pumps.** Jardine, D.M. (Kaman Sciences Corp., Colorado Springs, CO). *Sol. Eng.;* 1: No. 6, 22-23(Aug 1976).

A joint venture was formed in Colorado Springs to build and test a solar heated house to develop economically viable alternate methods of space heating. A two-year study program was funded by NSF. Some of the results, especially as they pertain to the use of various solar systems with different backup systems and components, are summarized. In general, it was found that a solar system matched with a heat pump will provide the greatest benefits to both the electric power industry and its customers. (WDM)

SOLAR COLLECTORS AND CONCENTRATORS

REFER ALSO TO CITATION(S) 2608

2618 (ANL—76-67) **Predicted heat-transfer performance of an evacuated glass-jacketed CPC receiver: countercurrent flow design.** Thodos, G. (Argonne National Lab., Ill. (USA)). May 1976. Contract W-31-109-eng-38. 37p. Dep. NTIS $4.00.

The heat-transfer performance of an evacuated glass-jacketed CPC-receiver facility, free on one end and fixed onto the glass jacket at the other, was carried out using heat-transfer relationships and the best information available in the literature. Specifically, the collector examined was a 3x-CPC facility, 8 ft long, with an entrance aperture 4.5 in. wide covered with a single glass cover, and provided with an aluminum reflecting surface (rho = 0.88). To maximize heat retention, a selectively treated receiver surface, epsilon = 0.11, was used. The optical efficiency of this CPC collector facility was calculated to be $eta_o = 0.536$. (WDM)

2619 (CONF-760821—11) **Weatherability of solar energy utilization materials: preliminary discussions.** Gilligan, J.E.; Brzuskiewicz, J. (IIT Research Inst., Chicago, Ill. (USA)). 1976. Contract E(11-1)-0578. 14p. Dep. NTIS $3.50.

From Sharing the sun, solar technology in the seventies; Winnipeg, Canada (15 Aug 1976).

The initial efforts of a program of research and experimental testing is described in which the optical and physical performance of materials for use in solar energy utilization devices will be determined before and after exposure to outdoor weathering tests. Materials which are currently in use and others which are being considered or developed for these applications will be characterized and exposed to natural solar radiation. Outdoor testing will be accomplished in Phoenix (Ariz.), Miami (Fla.), and Chicago (Ill.). The results of these tests, primarily the effects of outdoor exposure on optical and physical properties, will be compiled in a handbook, along with cost, availability and other pertinent information.

2620 (COO/2600—T1) **Development of high efficiency solar collector plates. Progress report, January 1, 1975—May 31, 1975.** Santala, T.; Sabol,R. (Texas Instruments, Inc., Attleboro, Mass. (USA)). 16 Jun 1975. Contract E(11-1)-2600. 51p. Dep. NTIS $4.50.

Composite metal technology is used to manufacture intermetallic compound (IC) absorption surfaces and to combine them integrally with a composite metal tube-in-sheet collector plate. Heat treatment process for Al—Ni system was optimized and α greater than or equal to 0.95 and epsilon less than or equal to 0.3 were obtained over a broad range of compounding conditions. Studies by SEM show that the Al—Ni IC surface is porous, spongelike and the dimensions of its fine structure are of the same magnitude as the wave length range of solar radiation, explaining at least partially the selectivity. Auger electron spectroscopy indicated that rather continuous aluminum oxide layer covers the fine structure of the Al—Ni. Low carbon steel—copper composite has been shown to be a suitable candidate for the collector plate. Additional work is required to resolve the conflicting requirements of the formation of the IC surface and of the manufacturing of the composite metal tube-in-sheet collector plate.

2621 (COO/2625—75/1) **Optical coatings for flat plate solar collectors. Final report, 16 September 1974—16 September 1975.** Mar, H.Y.B.; Lin, J.H.; Zimmer, P.B.; Peterson, R.E.; Gross, J.S. (Honeywell, Inc., Minneapolis, Minn. (USA). Systems and Research Center). 1975. 166p. (COO-NSF-C—957-F). Dep. NTIS $6.75.

Optical coatings that would enhance the economic feasibility of flat plate solar collectors were investigated. Etched antireflection coatings and selective absorbing plated and paint coatings that are low cost, and optically efficient coatings were investigated. Processes were developed for producing single and double layer AR coatings on glass by dipping in a silica saturated fluosilicic acid solution. The integrated solar reflection loss was reduced from 8 to 2 and 0.8 percent, respectively, for the single and double layer AR coating. Six months of continuous outdoor exposure reduced the solar transmittance of AR coated etched glass to that of clean unetched glass. After washing the exposed glass, the original as-etched solar transmittance was restored. The three most promising selective absorbing plated coatings and their typical optical properties were: black nickel (nickel-zinc sulfide), $\alpha = 0.95$, epsilon = 0.07; black chrome (chrome oxide), $\alpha = 0.95$, epsilon = 0.10; black iron (iron oxide), $\alpha = 0.85$, epsilon = 0.10. The superior optical performance of black nickel was offset by its relatively high cost and lack of durability. Black chrome currently offers the best combination of optical performance, cost, and durability. Black iron was the lowest cost plated coating and showed good durability but had relatively low solar absorptance. The use of polymer overcoats to increase both the solar absorptance and the durability of plated coatings was investigated and shows promise. For black chrome, a polymer overcoat could eliminate the need for a nickel plated substrate without degrading durability. Eliminating the nickel plating would result in significant cost reduction. For black iron, a polymer overcoat could improve durability and significantly increase solar absorptance. The primary disadvantage of a polymer overcoat is an increase in epsilon due to IR absorption in the polymer.

2622 (ORO—4927-76/1) **Engineering analysis and testing of water trickle solar collector. Progress report, June—November 1975.** Beard, J.T. (Virginia Univ., Charlottesville (USA). Dept. of Mechanical Engineering). Mar 1976. 18p. Dep. NTIS $3.50.

An outdoor solar collector test facility has been designed and constructed at the University of Virginia. The facility will be used for the simultaneous testing of four Thomason "SOLARIS" water trickle collector panels under different test conditions (angle of orientation, temperature, water flow rate, glazing design, etc.) with the same atmospheric exposure. The test facility was designed to include the instrumentation and other recommendations by the National Bureau of Standards (1). As expected, the preliminary results indicate that "SOLARIS" collectors have high collection efficiency under conditions where the inlet water temperature is near the ambient temperature. Comparisons are made with published results for traditional single and double glazed flat plate collectors. During the next phase of the research, final performance data will be obtained, the influence of various design modifications will be demonstrated, and an analytical model for collector performance will be developed for research and design applications.

2623 (UCRL—77906) **Horizontal collector with a mirror on the north side.** Clark, A.F. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 21 Jul 1976. Contract W-7405-Eng-48. 6p. (CONF-760657—2). Dep. NTIS $3.50.

From New England solar energy conference; Amherst, Massachusetts, United States of America (USA) (24 Jun 1976).

A mirror on the north side of a shallow, insulated, and covered pond is an inexpensive way of increasing the heat collection. A sketch and performance figures are given. (WDM)

2624 **Secondary reflectors for economical sun-tracking energy collecting systems: a concept.** Pasadena, CA; National Aeronautics and Space Administration (1975). vp.

Two secondary reflectors are proposed such that they track the reflected energy from stationary reflectors at ground level, thus reducing the weight and size of moving components of a sun tracking system.

2625 **Low cost solar tracking system.** Pasadena, CA; National Aeronautics and Space Administration (1975). vp.

A low cost mechanism is described which because of its small size and light weight reduces substantially the problem of providing continuous focusing of the sun's rays for an energy collecting system.

2626 Automatic solar tracker. Pasadena, CA; National Aeronautics and Space Administration (1975). vp.

No servo power is required by a device which tracks the sun to focus energy on a collector. Differential pressure of a condensable fluid such as freon against a fixed piston equalizes the radiant energy on a pair of black body elements which heat the fluid to drive the mechanism.

2627 (ERDA-tr—143) **Solar energy, DFVLR activities.** (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt e.V., Braunschweig (Germany, F.R.)). 11 Feb 1976. Translation of German report. 8p. Dep. NTIS $3.50.

The research programs of the DFVLR in the area of utilization of solar energy are briefly summarized in terms of systems with focusing collectors, systems with flat collectors, and wind turbines. (WDM)

GEOTHERMAL ENERGY

RESOURCE STATUS AND ASSESSMENT

USA

2628 (NSF-RA-N—74-246) **Analysis of the potential use of geothermal energy for power generation along the Texas Gulf Coast.** Wilson, J.S.; Shepherd, B.P.; Kaufman, S. (Dow Chemical Co., Freeport, Tex. (USA)). 15 Oct 1975. 69p. Dep. NTIS $4.50.

Three forms of potential geothermal energy may exist in the State of Texas: hot rocks in the Trans Pecos region, convection type geothermal water in the Rio Grande Rift basin, and geopressured geothermal water along the Gulf Coast. Of these, only the geopressured waters have been verified. Exploration wells for oil and gas have established the presence of deep hot water deposits along the coastal area, offshore and inland for 75 miles. These exist in thick shale and sand beds in the geopressured zone. The most favorable area appears to be at depths of 12,000 to 15,000 feet where the temperatures range from 300 to 400°F. Indications are that a series of relatively small, 10 to 50 megawatt, power plants could be located along the coastal plain of Texas. These plants could produce at least 20,000 megawatts and possibly as much as 100,000 megawatts under the most favorable conditions. Cost of the power appears to be in the range of 25 to 35 mills per kilowatt hour in 1980 providing the water is saturated with natural gas which could be sold to offset some of the cost. If the gas is present, at least 6 billion cubic feet per day of natural gas would be produced. Unit capital investment for such plants would exceed projected costs for nuclear or fossil fueled power plants. Successful development of a demonstration plant with public funds could establish the viability of geopressured waters as a source of power and natural gas and encourage private investment to exploit this energy source, should it prove competitive with other sources of electric power generation.

2629 NMSU annual energy conference: geothermal energy. Smith, C.; Morgan, P.; Jiracek, G.; Swanberg, C.A. *Geotherm. Energy Mag.*; 4: No. 7, 19-23(Jul 1976).

Papers were presented on a wide range of geothermal related subjects, including geothermal processes, the search for and evaluation of geothermal resources, and the economic, political, legal, environmental, and institutional problems associated with geothermal development. Progress reports were given on essentially all geothermal programs in New Mexico. A synopsis of the conference papers is given. Selected geothermal references for New Mexico are also given. (LBS)

GEOLOGY, HYDROLOGY, AND GEOTHERMAL SYSTEMS

USA

REFER ALSO TO CITATION(S) 2633, 2635

2630 Preliminary geothermal exploration of San Francisco volcanic field in northern Arizona (abstract). McKee, E.H. (Geological Survey, Menlo Park, CA); Smith, R.L.; Shaw, H.R. *Geol. Soc. Am., Abstr. Programs;* 6: No. 5, 458(Mar 1974).

From 27. annual meeting of the Rocky Mountain section of the Geological Society of America; Flagstaff, AZ, USA (27 Apr 1974).

2631 Major and trace element variation through a lava sequence and its implications on the magmatic evolution of the San Francisco Peaks, Arizona (abstract). Wenrich-Verbeek, K. (Pennsylvania State Univ., University Park). *Geol. Soc. Am., Abstr. Programs;* 6: No. 5, 482(Mar 1974).

From 27. annual meeting of the Rocky Mountain section of the Geological Society of America; Flagstaff, AZ, USA (27 Apr 1974).

2632 Structural features of the Salton Trough as seen from Skylab. Clarke, A.O. (Univ. of California, Riverside). *Calif. Geol.*; 29: No. 8, 187-190(Aug 1976).

Examination of four adjoining Skylab frames of the Salton Trough (taken 2 June 1973) allows regional tracing of important tectonic lineaments (faults, fractures, fault controlled valleys, and sand dunes) and a description of the entire region's structural features. Structural sketch maps compiled from each frame of the photo imagery are given and discussed. (MHR)

NON-USA

REFER ALSO TO CITATION(S) 4020

GEOTHERMAL EXPLORATION AND EXPLORATION TECHNOLOGY

2633 (VPI-SU—5103-1) **Evaluation and targeting of geothermal energy resources in the southeastern United States. Progress report, May 1, 1976—June 30, 1976.** Costain, J.K.; Glover, L. III; Sinha, A.K. (Virginia Polytechnic Inst. and State Univ., Blacksburg (USA)). 1976. Contract E(40-1)-5103. 33p. Dep. NTIS $4.00.

The optimum sites for geothermal development in the tectonically stable eastern United States will probably be associated with crustal igneous rocks containing relatively high concentrations of radiogenic heat-producing elements. In order to locate such sites, a methodology employing geological, geochemical, and geophysical techniques is being developed and applied. One geologic environment suitable for the storage of commercially exploitable geothermal heat at accessible depths is a radiogenic source buried beneath an insulating blanket of sediments of low thermal conductivity, such as the sedimentary rocks of the Coastal Plain of South Carolina, North Carolina, and Virginia. Preliminary determinations of geothermal gradients in Coastal Plain sediments of South Carolina indicate gradients that range from about 20°C/km to at least 45°C/km. Representative average gradients determined from bottom-hole temperatures are about 30°C/km. The observed gradients are consistent with those to be expected for an efficient sedimentary insulator with a low thermal conductivity.

GEOPHYSICAL TECHNIQUES AND SURVEYS

REFER ALSO TO CITATION(S) 4024

2634 Method of predicting geothermal gradients in wells. Reynolds, E.B. (to Continental Oil Co.). US Patent Application B 513,791. 10 Oct 1974. vp.

A method is devised for predicting the geothermal gradient of subterranean strata by determining velocity trends in the strata and comparing same with the velocity trends of formations for which geothermal gradients have previously been determined and plotted on semi-logarithmic paper as a family of curves of velocity trends versus geothermal gradients. The method comprises (a) determining the velocity trend at various depths of a wave propagated through the subterranean strata, (b) plotting the velocity trend versus depth on semi-logarithmic paper to generate a curve, and (c) comparing the curve obtained with a family of similar curves of known geothermal gradients.

2635 Gravity and magnetic studies of the Geysers-Clear Lake geothermal region, California. Isherwood, W.F. Boulder, CO; Univ. of Colorado (1975). 120p. University Microfilms Order No. 76-3912.

Thesis (Ph. D.).

Gravity and magnetic fields in The Geysers-Clear Lake region are interpreted in relation to the known geology and other available geophysical data. New gravity data provide additional detail within the area of geothermal steam production. The gravity field was separated into three components: (1) a regional field presumed to be due to deep crustal structure related to the continental margin; (2) a residual gravity low of approximtely 30 mgal centered over Mount Hannah and having an approximate diameter of 20 km, which was modeled as being due to a magma chamber

centered at a depth between 10 and 13.5 km; and (3) a closed residual low over the original steam production field. This low is attributed in part to reservoir structure within 2 km of the surface. Local magnetic highs correlate with surface outcrops of serpentinite and relief on the volcanic rocks. A long-range study of the mass balance of The Geysers steam field was initiated with the establishment of a precision gravity net tied to first-order leveling. Analysis of preliminary remeasurement after one-year's time suggests a high degree of recharge in the zone near the completion depth of producing wells. The migration of volcanism in the northern California Coast Range is shown related to the apparent northward migration of the Mendocino triple junction. (Diss. Abstr. Int., B)

2636 Application of the self-potential method to geothermal exploration in Long Valley, California. Anderson, L.A.; Johnson, G.R. (U.S. Geological Survey, Denver). *J. Geophys. Res.;* **81**: No. 8, 1527-1532(10 Mar 1976).

A self-potential survey made in the Long Valley caldera produced an anomaly derived from a dipolar source superimposed on potentials negative in polarity in relation to the area outside the caldera. The dipolar anomaly, consisting of negative and positive components differing amplitude by approximately 1 V, is centered over a resurgent dome in the west central part of the caldera. The exact nature of the potential source is unknown; however, electrofiltration processes caused by movement of heated groundwater that gives rise to streaming potentials are thought to be the principal cause of the dipolar anomaly. Diffusion potentials resulting from concentration differences between rising volcanic water and descending meteoric water may be responsible for the negative potentials measured within the caldera. Potential increases as high as 1100 mV were observed across the perimeter of the caldera.

2637 Evaluation of the geothermal potential of the Boise Front, Idaho (Abstract). Donaldson, P.R.; Applegate, J.K. (Boise State Univ., ID). *Geophysics;* **41**: No. 2, 350(Apr 1976).

From 45. annual SEG meeting; Denver, CO, USA (12 Oct 1975).

2638 Seismic exploration of Mono Basin, California. Pakiser, L.C. (Geological Survey, Denver). *J. Geophys. Res.;* **81**: No. 20, 3607-3618(10 Jul 1976).

A seismic exploration of Mono Basin, California, was conducted by the U.S. Geological Survey in 1970 and 1971 to resolve two conflicting interpretations regarding the thickness of the basin fill and the nature of the boundaries of the structure. Interpretation of the seismic data obtained leads to the conclusions that the depth to basement in Mono Basin in 2 to $2^1/_2$ km and that the structural deformation along the boundaries of the basin was accomplished by a combination of warping and faulting. Thus the geophysical data suggest a structural model that lies between the two extremes of interpretation. Geologic, seismic, magnetic, and gravity data all indicate the presence of a pile of intrusive and extrusive volcanic rocks near the center of Mono Basin.

GEOCHEMICAL TECHNIQUES AND SURVEYS

REFER ALSO TO CITATION(S) 2631

2639 (LBL—2966) Detailed chemical and radiometric study of geothermal waters and associated rock formations, with environmental implications. Bowman, H.; Hebert, A.; Wollenberg, H.; Asaro, F. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jul 1974. 14p. (CONF-740701—3). NTIS $4.00.

From 2. international conference on nuclear methods in environmental research; Columbia, Missouri, USA (29 Jul 1974).

Major trace and radioactive element abundances including non-condensible gas contents of hot and cold spring waters from geothermal resource areas in north-central Nevada are being studied. These studies will serve as a base-line for the evaluation of the environmental impact of geothermal resource development. Over 50 elements were looked for by x-ray fluorescence and high precision neutron activation analysis techniques. About 15 elements were usually detected in basic hot waters and substantially more in a single acid pool. Tungsten was unusually high in abundance in the hot waters but not in cold. In two areas, uranium was detected at the level of approximately 2-5 ppB in cold water and not detected in the hot spring waters. Attempts are being made to correlate the uranium hot-cold spring data with measurements of radon and radium in the springs in terms of the minimum age of the hot aquifer and the hot water flow rate.

EXPLORATORY DRILLING AND WELL LOGGING

2640 Big Island Puna well hotter. Benson, B. *Geotherm. Energy Mag.;* **4**: No. 7, 30-31(Jul 1976).

The temperature in the 6400 ft Puna test well on the Big Island reached 576°F and is predicted to reach the boiling point of 626°F at that depth. The Puna well begins on a volcanic flank at a point 600 ft above the ocean. It is believed that sea water will fill the shaft from sea level down to the bottom of the hole. Plans are made to complete and test the hole. (LBS)

LEGAL AND INSTITUTIONAL ASPECTS

REFER ALSO TO CITATION(S) 2628

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 2639

2641 Blowout of a geothermal well. The Geysers Geothermal Field, Sonoma County, California. Bacon, C.F. *Calif. Geol.;* **29**: No. 1, 13-17(Jan 1976).

The effects of the blowout of Union Oil Company geothermal well "G.D.C." 65-28 are described, photographed, and diagrammed. A geologic map of the vicinity is included. Attempts to control the well were described. This well, like over 50 percent of the wells drilled at The Geysers, was sited on a Quaternary landslide. An attempt was made to determine whether or not the well blew out as a result of renewed movements on the old slide. (MHR)

GEOTHERMAL ENGINEERING

GEOTHERMAL RESERVOIR AND WELL PERFORMANCE

REFER ALSO TO CITATION(S) 2640, 2641

RESERVOIR STIMULATION AND EXTRACTION TECHNOLOGY

2642 Chemical processing in geothermal nuclear chimney. Krikorian, O.H. (to USAEC, Washington, D.C.). Australian Patent 464781/B/. 18 Aug 1975. 43p.

Filed 8 May 1972, publ. 15 Nov 1973, priority USA 17 May 1971 (144168), copies available from the Commissioner of Patents, Canberra.

A closed rubble filled nuclear chimney is provided in a subterranean geothermal formation by detonation of a nuclear explosive device therein, with reagent input and product output conduits connecting the chimney cavity with appropriate surface facilities. Such facilities will usually comprise reagent preparation, product recovery and recycle facilities. Processes are then conducted in the nuclear chimney which processes are facilitated by temperature, pressure, catalytic and other conditions existent or which are otherwise provided in the nuclear chimney.

DIRECT ENERGY UTILIZATION

REFER ALSO TO CITATION(S) 2637

GEOTHERMAL DATA AND THEORY

ROCK-WATER-GAS INTERACTIONS

2643 Seawater—basalt interaction at 200°C and 500 bars: implications for origin of sea-floor heavy-metal deposits and regulation of seawater chemistry. Bischoff, J.L. (Univ. of Southern California, Los Angeles); Dickson, F.W. *Earth Planet. Sci. Lett.;* **25**: No. 3, 385-397(Apr 1975).

Seawater reacted with basalt at 200°C and 500 bars for 4752 hours changed chemically from an original slightly basic Na—Mg—SO_4—Cl solution to slightly acid dominantly Na—Ca—Cl solution. Mg and SO_4 decreased to near the limit of detection, and SiO_2 rose to near-saturation with amorphous silica. Ca dropped initially because of anhydrite precipitation, then rose to twice its initial value. K rose quickly to a steady level. Acidity at room conditions changed from the original pH of 7.9 to 3.9 at 72 hours, but subsequently increased to about 4.9. Fe and Mn passed through a maximum of 35 ppM at 1000 hours and steadily dropped thereafter to about 5 ppM. Low but significant levels of Ni and Cu entered the solution. The major solid products were anhydrite and montmorillonite. A small amount of glass decomposed

during the experiment. Conclusions based on the seawater—basalt reaction are: aqueous composition and alteration minerals were similar to those in the Iceland geothermal fields; sufficient heavy metals were solubilized to account for the deep-sea heavy-metal deposits; and the reaction provides a capacity for an adequate sink for Mg and SO_4, as well as potential source of H^+ needed for the geochemical balance of the oceans.

ISOTOPE AND TRACE ELEMENT STUDIES

REFER ALSO TO CITATION(S) 3604

OTHER

REFER ALSO TO CITATION(S) 4019, 4021, 4022, 4023

TIDAL POWER

TIDAL POWER PLANTS

DESIGN AND OPERATION

2644 Submarine electrical energy generating apparatus. Lesser, J.M. US Patent 3,912,937. 14 Oct 1975. Filed date 20 Jul 1973. 6p.

This invention relates to a submarine electrical energy generating apparatus for utilizing the currents of oceans and seas to generate electricity comprising an electrical generator in a waterproof compartment, a turbine comprising a rotatable shaft having dual pitched wheel vanes extending therefrom and louvers pivotally mounted on said vanes in such manner and so structured so as to be under the constant control of the water current, and means operatively associated with said shaft and said generator for transmitting movement from the shaft to the generator.

2645 Water current power generator system. Straumsnes, O.R. US Patent 3,928,771. 23 Dec 1975. Filed date 5 Apr 1974. 4p.

A water current power generator system comprises one or more generator ships firmly anchored to the water bottom to generate power from sea currents or the tidal flow of rivers. The hull of a typical ship includes an inlet where the moving water enters and drives blades hinged to a toothed belt which moves about a pair of rollers. As the blades move about the forward roller, the hinged blades are driven outwardly to a right angle position to be driven by the water flow. The blades fold into a collapsed position as they pass over the rear roller and move in a direction opposite the water flow thereby minimizing resistance to the water flow. Generally, a pair of toothed belts are provided within each shaped inlet with a thrust member therebetween to direct the water toward the blades. The belts are mounted vertically within the hull to encounter as much of the water pressure as possible. The water then flows out the rear of the hull through a shaped outlet which is smaller than the inlet. In an alternate embodiment, vertical water wheels with collapsible blades are used instead of toothed belts. This variation would include at least one of such wheels positioned at the inlet and having hinged members serving as blades mounted on the wheels to catch the water flow thereby driving the wheel. The blade would then pivot to an open position minimizing resistance to the motion of the wheel as it moves around the axis of said wheel.

WAVE ENERGY CONVERTERS

2646 Wave driven power generators. Neville, R.L. US Patent 3,911,287. 7 Oct 1975. Filed date 13 Mar 1974. 4p.

Two one-way clutches on a power output shaft are driven through two oppositely driven power trains driven by a lever arm oscillated by a float raised by waves and lowered by gravity. In an alternate embodiment, a plurality of floatoscillated lever arms are spaced apart a fraction of a wave length and drive pairs of one-way clutches on a power output shaft which drives a positive displacement pump. Another embodiment includes a paddle wheel carried by a lever arm oscillated by a float raised and lowered relatively rapidly by waves and relatively slowly by tide, a power output shaft driven unidirectionally by oppositely driven power trains through two one-way clutches, and a current driven paddle wheel carried by the arm and driving the shaft through two additional one-way clutches.

2647 Electrical stations operated by waves. Filipenco, G.D. US Patent 3,912,938. 14 Oct 1975. Filed date 25 Jan 1974. 4p.

Electrical energy is produced by platforms floating upon water expanse oceans, seas, rivers or lakes, and movable by waves. The platforms carry electrical generators as well as means transforming the kinetic energy of the waves into mechanical energy which actuates these generators. These means may consist of hydraulic turbines combined with a pump water accumulator capable of transmitting water under pressure to a hydraulic motor operating the electrical generator. Other means may include floats or a pendulum swinging under the action of the waves.

2648 Apparatus and method for extracting wave energy. Salter, S.H. US Patent 3,928,967. 30 Dec 1975. Priority date 15 Nov 1973, United Kingdom of Great Britain and Northern Ireland (UK). 10p.

An apparatus and method is described for extracting the tremendous energy from a wave pattern as for example on the surface of a body of water which comprises a plurality of movable members so shaped that the surface of the member which engages the incoming wave causes the members to rotate about a substantially horizontal axis and remove energy from the wave and wherein the rear portion of the movable member is constructed so as to move with minimum energy transfer between the movable member and the fluid. The energy extracted by the movable member is converted into a hydraulic, electrical, mechanical, or chemical energy so as to allow the wave energy to be directly converted into useable form.

WIND ENERGY

WIND ENERGY ENGINEERING

2649 Energy equations: taking power off the wind. Bruckner, A. *New Sci.*; No. 891, 812-814(28 Mar 1974).

The history of the development of wind power is reviewed. Work on wind power development at Oklahoma University and City University, London, is cited. (Fuel Abstr.)

TURBINE DESIGN AND OPERATION

REFER ALSO TO CITATION(S) 2627

ELECTRIC POWER ENGINEERING

POWER GENERATION

REFER ALSO TO CITATION(S) 3342

COOLING SYSTEMS

REFER ALSO TO CITATION(S) 3086, 3872, 3873, 3874

2650 Testing of large natural draught cooling towers. Inertia of cooling towers and its influence on interpretation of results. Vandamme, E. (Electricite de France, 75 - Paris). *Tech. Mod.*; **67**: No. 7, 57-63(Jul 1975). (In French).

Measurements were carried out on a large cooling tower. The determination of its thermal inertia and the effect on the operation analysis are presented.

2651 Role of geometric imperfections in the collapse of a cooling tower. Kemp, K.O.; Croll, J.G.A. (Univ. Coll., London). *Struct. Eng.*; **54**: No. 1, 33-37(Jan 1976).

Effects of geometric imperfections in the form of the meridians of hyperboloidal cooling towers are re-assessed. It is shown that even moderate imperfections induce hoop stresses in the vicinity of the imperfection that are of the same order of magnitude as the meridional stresses that would occur in this same area of the perfect shell. By examining a shell of form similar to the Ardeer shell which recently collapsed, it is indicated that imperfections may have had an important contributory role in initiating this failure. It is suggested that in future design greater attention will be required in specifying the circumferential steel distributions and the tolerances in geometric imperfection.

2652 Engineering and ecological considerations in licensing once-through cooling systems for power plants. Brodfeld, B.; Hof-

mann, P. (Stone and Webster Engineering Corp., Boston). *Trans. Am. Nucl. Soc.*; **23**: 456-457(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2653 Air operated underground cooler means with natural lift. Heller, L.; Forgo, L.; Bakay, A. (to Transelektro Magyar Villamossagi Kulkereskedelmi Vallalat). US Patent 3,970,140. 20 Jul 1976. Priority date 4 Sep 1971, Hungary. 4p.

The difference in density between heated and unheated air is used to provide flow of air across a heat transfer means located underground. An underground passageway connects an inlet orifice with an outlet orifice for flow of ambient air therethrough. The passageway comprises at least one essentially vertical shaft, said vertical shaft terminating at the outlet orifice and containing proximate its lower end said heat transfer means.

2654 Cooling tower design and forming speed erection. *Eng. News-Rec.*; **197**: No. 10, 23-24(2 Sep 1976).

Two construction techniques are described which are used to facilitate construction of cooling towers. The techniques are a self-raising system of jump-forming the tower shell and concurrent construction of the shell and cooling sections. (DG)

COMBINED AND BINARY CYCLES

REFER ALSO TO CITATION(S) 2318, 2350

2655 (CONF-760224—2) **Improved fuel utilization by introduction of gas—steam turbogenerators.** Gassert, H. (Brown, Boveri und Cie A.G., Mannheim (Germany, F.R.)). 1976. 24p. (In German). Dep. NTIS (US Sales Only) $3.50.

From Technical meeting on improved energy utilization in thermal power plants; Juelich, German, Federal Republic of (F.R. Germany) (4 Feb 1976).

2656 (SAND—76-0277) **Flux compression topping stage.** Leisher, W.B.; Cowan, M.; Tucker, W.K.; Wesenberg, D.L.; Cnare, E.C. (Sandia Labs., Albuquerque, N.Mex. (USA)). Jun 1976. Contract AT(29-1)-789. 21p. Dep. NTIS $3.50.

A topping stage, to be used with conventional coal or oil-fired generating stations, which is based on a linear reciprocating flux-compression generator called PULSAR is described. All, or part, of fuel combustion may take place in the PULSAR unit. The thermodynamic cycle is similar to that of a free-piston diesel engine except that combustion takes place initially at constant volume, then at constant temperature during expansion. The hot (1200 to 2000°K) exhaust gases serve as a heat source for steam production. The electrical portion of PULSAR consists of a superconducting magnet, generator coil, piston-like armature, and pulse-to-60 Hz conditioning equipment. Armature velocity is maintained sufficiently high (135 m/s) to assure that flux compression occurs. Calculations and experimental data show that a load electrical energy of approximately two times the superconducting magnetic energy can be obtained for each cycle through extracting about half of the kinetic energy from the armature. Remaining kinetic energy is used to compress incoming air for the next cycle. The preliminary calculations presented show that for a conventional plant overall thermal efficiency of 35 percent, addition of the PULSAR stage can easily increase overall thermal efficiency to 46 percent at a net output of 800 MW with higher efficiency possible. PULSAR output is 440 MW while the conventional plant provides the remaining 360 MW. PULSAR is also applicable to smaller plants and could be built as a strap-on unit for existing plants. Descriptions of problem areas, future work, and experimental results are included.

2657 Electrochemical heat engines for direct electric power generation and energy storage. Elliott, G.R.B.; Trela, W.J.; Dials, G.E. New York; American Institute of Aeronautics and Astronautics, Inc. (1975). 7p.

From 11. AIAA/SAE propulsion conference; Anaheim, CA, USA (29 Sep 1975).

Batteries can be operated in heat engine cycles analogous to the cycles of usual mechanical heat engines but without the mechanical motion of pistons, turbines, etc. These electrochemical cycles can be used for direct generation of electric power and for storage of energy. The Los Alamos Scientific Laboratory is in the initial stages of development of such engines which can accept heat in the temperature range of 1700 to 900°K, then drop the temperature to the range 800 to 600°K while doing useful electrochemical work. These systems offer promise as topping cycles for steam turbines, and they could be used for mine-mouth generation of electric power following in situ gasification of coal--here the rejected heat from the generation can be used in endothermic processes underground. Such processes include preliminary drying of the coal bed, frequently a necessary step in in situ gasification, as well as coal pyrolysis to produce a substitute feedstock for petroleum refineries of the future, plus gasification itself.

POWER PLANT COMPONENTS

REFER ALSO TO CITATION(S) 2279, 2280, 2655, 2660

2658 (CONF-760224—1) **Possible efficiency improvements in steam and gas turbines.** Haas, H. (Kraftwerk Union A.G., Muelheim an der Ruhr (Germany, F.R.)). 1976. 26p. (In German). Dep. NTIS (US Sales Only) $4.00.

From Technical meeting on improved energy utilization in thermal power plants; Juelich, German, Federal Republic of (F.R. Germany) (4 Feb 1976).

2659 (CONF-760224—5) **Utilization of advanced materials and processing technologies for thermal power plants.** Schoch, W. (Grosskraftwerk Mannheim A.G. (Germany, F.R.)). 30 Jan 1976. 58p. (In German). Dep. NTIS (US Sales Only) $4.50.

From Technical meeting on improved energy utilization in thermal power plants; Juelich, German, Federal Republic of (F.R. Germany) (4 Feb 1976).

WASTE HEAT UTILIZATION

2660 (CONF-760224—3) **Formation of stored heat by means of bleeder steam in load sinks and their use in peak power occasions.** Bitterlich, E. (Deutsche Babcock und Wilcox A.G., Oberhausen (Germany, F.R.)). 1976. 31p. (In German). Dep. NTIS (US Sales Only) $4.00.

From Technical meeting on improved energy utilization in thermal power plants; Juelich, German, Federal Republic of (F.R. Germany) (4 Feb 1976).

ECONOMICS

REFER ALSO TO CITATION(S) 3329, 3330, 3339

2661 (CONF-760224—4) **Limits of possible improved energy utilization from the financial viewpoint.** Trenkler, H. (Vereinigung Deutscher Elektrizitaetswerke e.V. (VDEW), Frankfurt am Main (Germany, F.R.)). 1976. 60p. (In German). Dep. NTIS (US Sales Only) $4.50.

From Technical meeting on improved energy utilization in thermal power plants; Juelich, German, Federal Republic of (F.R. Germany) (4 Feb 1976).

2662 United States Bureau of Labor Statistics. FFC Form No. 3-P. *Fed. Regist.* (*Wash., D.C.*); **41**: No. 114, 23723-23727(11 Jun 1976). (18CFR141).

From Conservation of Power and Water Resources, 18CFR141, Federal Power Commission—Labor Department, residential electric bill data.

A total of 404 residential electric bills comprise the monthly sample for the Consumer Price Index. Between three and five residential bills are reported for each community canvassed. Each residential electric bill consists of a net base bill, a total bill and where applicable a fuel adjustment, sales and/or gross receipts tax, and other tax or charge. If applicable, respondents also provide the monthly fuel cost and the fuel adjustment per kilowatt-hour and the rate of sales or other tax.

2663 Proposed implementation. *Fed. Regist.* (*Wash., D.C.*); **41**: No. 167, 36041-36043(26 Aug 1976). (49CFR1106).

From Transportation, 49CFR1106, Interstate Commerce Commission—Energy Policy and Conservation Act of 1975.

The Energy Policy and Conservation Act directs and authorizes that certain steps be taken by the Federal and State governments to reduce demand for energy, increase domestic energy supplies, and conserve existing energy supplies through energy conservation programs and improvements in the energy efficiencies of motor vehicles and other consumer products. Consistent with this mandate, efforts should also be taken to increase the energy efficiency of other modes of surface transportation subject to Commission regulation. The purpose of these regulations is to establish procedures for facilitating the Commission's discharge of its duties under the Energy Policy and Conservation Act of 1975. These guidelines apply to all proceedings before the Commission.

2664 New FPC Form No. 158. Annual report of power system energy accounting, peak demands, and intersystem purchases and sales. *Fed. Regist.* (*Wash., D.C.*); **41**: No. 172, 37232-37233(2 Sep 1976). (18CFR141).

From Federal Power Commission.

Notice is hereby given pursuant to the Administrative Procedure Act, 5 U.S.C. 553, and sections 10, 19, 20, 202, 205, 206, 207, 304, 309 and 311 of the Federal Power Act, that the Commission proposes to add section 141.69 to Part 141 of the Approved Forms under the Federal Power Act to provide that a new FPC Form No. 158 be required for reporting. The proposed new form would be entitled "Annual Report of Power System Energy Accounting, Peak Demands, and Intersystem Purchases and Sales."

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 2652, 3313, 3314, 3331, 3341

THERMAL EFFLUENTS

2665 Impact of thermal discharges on air quality. Peterson, J.T. Washington, DC; Committee on Public Works (1973). 43p. GPO.

Observed and potential local, regional, and global scale effects of rejecting heat to the environment from industrial processes are examined, with heavy emphasis on electric power plants. Mechanical and natural draft cooling towers, dry cooling towers, and cooling lakes and ponds are evaluated for local weather effects including fogging, icing, cloud formation, and salt drift. Interactions between cooling tower plumes and stack plumes are treated. Heat rejection to the atmosphere and to natural bodies of water are compared. The effects of heat generation from urban areas on temperature inversions, pollutant diffusion, frost, snowfall, humidity, fog occurrence, winds, and precipitation are discussed.

NOXIOUS GAS CONTROL

REFER ALSO TO CITATION(S) 2272, 2337, 3426, 3641, 3804, 3811

SITE SELECTION

REFER ALSO TO CITATION(S) 3820

POWER TRANSMISSION AND DISTRIBUTION

REFER ALSO TO CITATION(S) 2685

2666 (RED—76-107) **Study by the Staff of the U.S. General Accounting Office. Status of federal and private research and development efforts to conserve energy by reducing electric power transmission losses.** (General Accounting Office, Washington, D.C. (USA)). 1 Jun 1976. 20p. General Accounting Office, Washington, DC.

Electric power losses during transmission, i.e., while moving power at high voltages from the generation site to load centers, are caused by electrical resistance, skin effect, corona discharge, and insulation losses. The Electric Power Research Institute (EPRI) budgeted $21 million and ERDA budgeted $11 million for fiscal year 1976 for power transmission research. The scope and emphasis of these research programs are reviewed. (LCL)

2667 (UCRL-Trans—1525) **Insulation problems in SF_6 insulated metal-clad installations.** Boeck, W. Translated by J.W. Armstrong from *Bull. Schweiz. Elektrotech. Ver.*; **66**: 1234-1241(1975). 34p. Dep. NTIS $4.00.

Considerable progress has been achieved in recent years in the field of gas discharge processes in SF_6. The basic relationships are shown schematically while to a great extent doing without quantitative statements. The latest research results by various authors are thereby taken into consideration and introduced in a relationship which makes possible a deeper understanding of the insulation behavior of SF_6.

AC SYSTEMS, EHV AND UHV

REFER ALSO TO CITATION(S) 3343

SUPERCONDUCTING AND CRYOGENIC SYSTEMS

2668 (BNL—20250) **Long distance bulk power transmission using helium-cooled cables.** Forsyth, E.B.; Stewart, J.R.; Williams, J.A. (Brookhaven National Lab., Upton, N.Y. (USA)). 1976. Contract E(30-1)-16. 8p. (CONF-760913—1). Dep. NTIS $3.50.

From Underground transmission and distribution; Atlantic City, New Jersey, United States of America (USA) (27 Sep 1976).

The technical and economic feasibility of using helium-cooled underground cables for power transmission on a 43 mile-long 345 kV system planned for Long Island and on a 350 mile-long transmission route to connect with an existing 500 kV network in Pennsylvania are examined. The technical considerations, cost analysis, and cost summaries are presented. It is concluded that helium-cooled underground transmission systems are capable of performing the function of EHV and UHV overhead transmission lines. However, the specific costs are higher than the overhead transmission costs by a factor of 3. Consequently, the use of superconducting lines only appears probable in urban and suburban areas of heavily developed regions of the US where overhead lines are undesirable. (LCL)

NUCLEAR POWER PLANTS

REFER ALSO TO CITATION(S) 3320

2669 (CPC—1-A(Rev.4)) **Quality assurance program manual for nuclear power plants. Volume I. Policies.** (Consumers Power Co., Jackson, Mich. (USA)). 1 Mar 1976. 149p. Dep. NTIS $6.00.

Quality assurance program policies used by Consumers Power Company during all phases of nuclear power plant design, construction, and operation are presented.

2670 (DEU—73-28(Ed.1974)) **Business report, 1974.** (Kraftanlagen A.G., Heidelberg (Germany, F.R.)). 1974. 40p. (In German). INIS.

With figs. and tabs. Available from ZAED.

Kraftanlagen Heidelberg AG present their balance for 1974 as well as the order position and the development of the firm in that year.

2671 (NP—20998) **Quality assurance program description. Topical report SDQAPD-1.** (San Diego Gas and Electric Co., Calif. (USA)). 1975. 105p. San Diego Gas and Electric Co., CA.

The topical report presented describes the SDG and E QA Program that is applied to the design, procurement, construction, and preoperational testing of nuclear power plants. The QA plan describes the SDG and E organizational structure for quality assurance; identifies the functions, duties, and responsibilities of key departments and individuals; describes interrelationships and interfaces among internal groups and external organizations; delineates program requirements, and prescribes methods of implementation. SDG and E Procedures and Directives provide detailed direction for accomplishment of program requirements in consonance with the methods specified in the QA Plan.

2672 Improvements in steam cycle electric power generating plants. Bienvenu, C. (to Electricite de France). French Patent 2,235,606/D. 27 Jun 1973. 6p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France).

The invention relates to a steam cycle electric energy generating plants of the type comprising a fossil or nuclear fuel boiler for generating steam and a turbo alternator group, the turbine of which is fed by the boiler steam. The improvement is characterized in that use is made of a second energy generating group in which a fluid (e.g. ammoniac) undergoes a condensation cycle the heat source of the cycle being obtained through a direct or indirect heat exchange with a portion of the boiler generated steam whereby it is possible without overloading the turbo-alternator group, to accomodate any increase of the boiler power resulting from the use of another fuel while maintaining a maximum energy output. This can be applied to electric power stations.

2673 Report on the NUCLEX '75. *At.-Inf.*; No. 10, 13-15(1975). (In German).

2 figs.

Following a brief survey of the NUCLEX '75 international fair for nuclear industry, the course of the press conference is reported on.

2674 Present situation and development of nuclear power plant technology. Altvater, W. pp 3-27 of In Energy technology with regard to future developments. Honnens, M.; Zobel, M. (comps.). Frankfurt am Main, F.R. Germany; Verlags- und Wirtschaftsgesellschaft der Elektrizitaetswerke m.b.H. (1975). (In German)

6 figs.; 2 tabs.

The author's observation of the history of nuclear power plant development leads him to the present 'state of the technology' and enables him to analyze the properties of different reactors. Important focal points of research such as safety, standardization,

and cooling problems are illustrated by the example of a German pressurized-water reactor.

2675 Operating experience in nuclear power stations. Ettemeyer, R. pp 28-44 of In Energy technology with regard to future developments. Honnens, M.; Zobel, M. (comps.). Frankfurt am Main, F.R. Germany; Verlags- und Wirtschaftsgesellschaft der Elektrizitaetswerke m.b.H. (1975). (In German)

3 figs.; 1 tab.

Following a survey of the design principles of a nuclear power station (boiling-water and pressurized-water reactor), the author describes the operating behavior of German reactors and their response to failures in the primary components. Due to the immediate interest of the problem, a chapter entitled 'radiation exposure' deals with reactor safety and radiation protection.

2676 The role of nuclear power. Guck, R. (Badenwerk A.G., Karlsruhe (F.R. Germany)). pp 30-37 of In The electricity industry in the Federal Republic of Germany. Eymueller, T.; Uebbing, H.; Boecker, H. (comps.). Frankfurt am Main, F.R. Germany; Institut fuer Bilanzanalysen (1975). (In German)

2 figs.; 3 tabs.

Based on the present development in the FRG, a report is given on the programs, projects and plans for nuclear power plants in the FRG up to 1985. It is assumed that in the years to come, nuclear power plants will take over the main part of the base-load generation. The problems involved are discussed which last but not least concern the investments.

2677 Nordic cooperation in research, development and technology exchange in the energy field. Baecklund-Larsson, R. (Nordisk Industrifond, Stockholm (Sweden)); Marcus, F. (Nordic Co-ordination Committee for Atomic Energy, Risoe (Denmark)); Hagen, E. (Nordforsk, Stockholm (Sweden)); Haahr, I.; Blomqvist, B.; Ludviksson, V.; Owe, C.; Wennerberg, S. *Nord. Utredn.;* No. 30, p.(1975). (In Swedish).

ad hoc committee of senior civil servants has, in cooperation with the Swedish Steam Boiler Association, studied the need for, and possibilities of, extended cooperation between the Nordic countries in the energy field. The report does not cover cooperative projects already in progress, including several in the nuclear energy field. However a need for work on district heating, both from power generating and special purpose reactors, and industrial process reactors is identified. Brief surveys are given of the national and Nordic organizations active in the energy field.

2678 Energieversorgung. BBC im Kernkraftwerksbau. (Energy supply. BBC in nuclear power plants construction). Mannheim, F.R. Germany; BBC (Jun 1975). 27p. (In German).

42 figs.; 6 tabs. Short communication only.

2679 Nuclear energy and the energetic challenge. *Rev. Gen. Nucl.;* **1**: No. 3, 160-174(Jul 1975). (In French).

The author analyses the papers presented by F. Spaak and A. Giraud at the Paris Conference on the maturity of nuclear energy. Isolating the essential characteristics of world energetic consumption, the author points out that the long-terme preservation of resources requires a slowing down of the present consumption rate. The spontaneous actions conducted within the framework of new international relations aiming at a better distribution of the world's wealth between industrialized countries and poor countries should be substituted for the bare techniques of the market. By meeting these energetic requirements, nuclear power is called upon to take a predominant part during the new few decades. This is what emerges from the "summaries" established from the various hypotheses, which notably show that recourse, to breeders is necessary without further delay in order to cope with the problems posed by uranium supplies.

2680 Connecting large power stations into the systems. Preuss, E.J. (Nordwestdeutsche Kraftwerke A.G., Hamburg (F.R. Germany). Elektrotechnische Abt.). *Elektrotech. Z., A;* **96**: No. 10, 439-443(Oct 1975). (In German).

7 figs.

The article shows from the point of view of an electricity supply undertaking as the builder, and later the operator, the problems which arise when adding large power stations into the system. Using the example of the 1,300 MW Unterweser power station those points are listed specially which, because the problems are due to their peripheral position in the German grid, must be studied in detail.

2681 Development trends in power economy and related particularities of nuclear power. Belostockij, A.M. *Arch. Energiewirtsch.;* **29**: No. 10, 989-1001(Oct 1975). (In German).

4 figs.; 3 tabs.; 8 refs. Translated from Russian. Also published in At. Tekh. Rubezhom 1975 no. 3 p. 1-10.

This article deals with a concept, presented by the International Institute for Applied Systems Analysis (IIASA), of future power-economic developments in the light of the energy crisis. Nuclear reactors are the foundation of the concept. The demands now made on them differ from the traditional demands as follows: whereas nuclear reactors used to be exclusively intended for generating power, they will have to serve in future for generating power and process heat. As a result of increasing shortage, natural hydrocarbons, petroleum, and natural gas will have to be replaced by synthetic hydrocarbons on the basis of coal gasification. It is expected that the process heat needed for this will be made available in good time by the HTR.

2682 The influence of the changes in the energy sector on the geographical and settlement structure. Pt. 1. Short- and long-term development trench of the energy supply structure. Arens, H.J. *Energiewirtsch. Tagesfragen;* **25**: No. 11, 520-524(Nov 1975). (In German).

2 figs.; 12 refs.

The approaching changes within the framework of a new energy and energy research policy in the energy sector in the FRG, the potential energy supply systems in the near and far future, as well as the competitive chances of the thus resulting new secondary energy carriers are outlined.

2683 Prospects of Soviet energetics. Peer, V.A. *Energiewirtsch. Tagesfragen;* **25**: No. 11, 529-530(Nov 1975). (In German).

1 tab.

Following a brief survey on the structure of the Soviet primary energy supply, a report is given on the momentary state of the nuclear energy programme as well as of the fusion research in the USSR.

2684 Nuclear power is on the uprise. The consolidation of nuclear power plant engineering. A report from the Nuclex '75 at Basel. Lenz, W. (Verein Deutscher Ingenieure, Duesseldorf (F.R. Germany)). *VDI (Ver. Dtsch. Ing.) Nachr.;* **29**: No. 46, 2(Nov 1975). (In German).

From NUCLEX; Basel, Switzerland (7 Oct 1975).

1 fig.; 1 tab.

An article is presented about the display of the biggest groups represented at the NUCLEX '75, and about the special meetings which took place during that time.

2685 Nuclear energy in the electricity supply industry of the FRG in 1974. *Atomwirtsch., Atomtech.;* **20**: No. 12, 621-622(Dec 1975). (In German).

3 tabs.; 1 ref. Short communication only.

2686 The government's expenditure for nuclear energy in the FRG in 1973-1975. *Atomwirtsch., Atomtech.;* **20**: No. 12, 630-631(Dec 1975). (In German).

4 tabs. Short communication only.

2687 Federal expenditures for nuclear energy in the budget for 1976. *Atomwirtsch., Atomtech.;* **20**: No. 12, 633(Dec 1975). (In German).

1 tab. Short communication only.

2688 Reactor types - state of development and trends. Oldekop, W. (Technische Univ. Braunschweig (F.R. Germany). Lehrstuhl fuer Raumflugtechnik und Reaktortechnik). *Tech. Ueberwach.;* **16**: No. 12, 355-363(Dec 1975). (In German).

14 figs.; 1 tab.; 15 refs.

A survey of the essential characteristics of the reactors of the first and second generation as well as a look into the future development of the reactor types is given. Numerous diagrams and a table of technical data of typical power reactors supplement the work.

2689 The transition from oil and coal to nuclear energy in the FRG under aspects of economics and raw materials policy. Schikorr, W.M.; Rogner, H.H. (Kernforschungszentrum Karlsruhe (F.R. Germany). Inst. fuer Angewandte Systemanalyse). pp 822-825 of In Reactor conference, Duesseldorf, 30.3.-2.4.1976. Section 4: Reactor concepts and economics. Eggenstein-Leopoldshafen, F.R. Germany; ZAED (1976). (In German)

From Reactor meeting; Duesseldorf, F.R. Germany (30 Mar 1976).

5 figs.; 2 tabs.; 5 refs. Short communication only.

2690 Nuclear R and D in Sweden. Aler, B. (AB Atomenergi). *Nucl. Eng. Int.;* **21**: No. 238, 46-49(Jan 1976).

The Swedish nuclear research and development programme is examined. Nuclear power is currently being introduced as a major source of energy, the present program being restricted to BWRs. Most R and D is conducted by industry and the utilities. The method of financing nuclear development and the role of the Swedish Government is discussed. Reactor safety problems form a major part of the programme. Waste disposal and associated problems, and the possibility of supporting district heating schemes by nuclear power units are also included. It is considered that any future new reactors should be based on industrially mature technology developed in other countries. Consideration is given to Swedish uranium resources and the possibility of establishing a uranium industry. Reference is made to Swedish effort in fusion reactor technology.

2691 Nuclear industry chart no. 20 - Sweden. *Nucl. Eng. Int.*; **21**: No. 238, 39-40(Jan 1976).

A folding chart is presented of the Swedish nuclear industry, which shows the government bodies, companies, utilities and other groups who participate in the nuclear field. Their special interests and activities and affiliations with each other and with international organisations are indicated.

2692 Survey of Sweden. The energy situation and nuclear power. Gradin, R.U. *Nucl. Eng. Int.*; **21**: No. 238, 31-34(Jan 1976).

By Government stimulation of stringent measures to economize on energy, Sweden aims to reduce its growth rate of energy consumption from a typical 4.5% per annum to an average of 2% up to 1985, and to zero from the beginning of the 1990s. Since a very large proportion of energy consumption is provided by imported oil for heating and transport it is in these areas that the greatest savings can be made, which means that within this 2% there is scope for electricity consumption, and industrial energy consumption in general, to grow at a higher rate. This situation was the main consideration in deciding on a figure of 13 reactors to be ordered for operation by 1985 instead of the 15 requested at one time by the utilities.

2693 Scope and trends in indigenous industry. Smith, D. *Nucl. Eng. Int.*; **21**: No. 238, 42-46(Jan 1976).

The choice of suppliers for Swedish reactors is considered. There is incentive to diversify in order to ensure maximum security of supply, and increasing competition from overseas. The resources which Sweden's own manufacturing companies have to offer the nuclear industry are discussed. These include reactor suppliers, pressure vessels, steel products, mechanical equipment and waste treatment plants. The activities of Swedish consultancy services and of companies concerned with fuel cycle sources and civil engineering work are outlined.

2694 Nuclear power: the achievements, the problems and the myths. Hill, J. (UKAEA). *Atom (London)*; No. 232, 34-45(Feb 1976).

Presented as the Melchett Lecture at Institute of Fuel on 20 Nov 1975.

The total energy requirements of the UK and problems associated with various energy sources including wind, tide, solar, geothermal, hydroelectric, and fossil fuels are reveiwed and their future contribution considered. Nuclear power is discussed with emphasis on costs, technical problems, and future developments.

2695 Nuclear fission. Goedkoop, J.A. (Stichting Reactor Centrum Nederland, The Hague). *Atoomenerg. Haar Toepass.*; **18**: No. 2, 41-45(Feb 1976). (In Dutch).

It is pointed out that although a comparison of nuclear fission and coal as sources of energy shows that the former has more advantages, yet there is still much opposition to its further development. The contribution that can be made by research in the next 25 years to the removal of this opposition is examined. In particular LWR, LOFT, HTGR, the fast reactor, and the OKLO phenomenon are considered.

2696 NRC progress report on standardization. Heineman, R.E. (Nuclear Regulatory Commission, Washington, DC). *Trans. Am. Nucl. Soc.*; **23**: 421(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2697 SNUPPS duplicate-plant concept. Schnell, D.F. (Union Electric Co., St. Louis). *Trans. Am. Nucl. Soc.*; **23**: 421(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2698 License to manufacture option. Collier, A.R. (Offshore Power Systems, Jacksonville, FL). *Trans. Am. Nucl. Soc.*; **23**: 421-422(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2699 Second-generation standardization. Roell, T.L.; Farrell, R.E.; Vellender, G.C. (Flour Pineer Inc., Chicago). *Trans. Am. Nucl. Soc.*; **23**: 422-423(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2700 Replication: does it work. Coughlin, J. (Public Service Indiana, Plainfield). *Trans. Am. Nucl. Soc.*; **23**: 423(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2701 Safeguards: experience and future needs. Gray, J.E. (International Energy Associates, Ltd., Washington, DC). *Trans. Am. Nucl. Soc.*; **23**: 442-443(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2702 Nuclear Plant Administrative Training Manual Development. Motl, G.P. (NUS Corp., Sherman Oaks, CA); Balfour, H.R. *Trans. Am. Nucl. Soc.*; **23**: 481-482(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2703 Comparative method for plant and component productivity by simplified histograms. Matsumura, M. (Nuclear Power Training Center, Ltd., Tsuruga, Japan). *Trans. Am. Nucl. Soc.*; **23**: 484(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2704 Quantification of operation experience and incident reports for reliability analysis and improvement of task performance. Husseiny, A.A.; Sabri, Z.A.; Danofsky, R.A. (Iowa State Univ., Ames). *Trans. Am. Nucl. Soc.*; **23**: 484-487(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2705 Nonlinear perturbation technique for the nuclear fuel cycle. Harris, D.R.; Becker, M. (Rensselaer Polytechnic Inst., Troy, NY). *Trans. Am. Nucl. Soc.*; **23**: 534-535(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, BOILING WATER COOLED

REFER ALSO TO CITATION(S) 2910, 2912, 2925, 2927, 2928, 2930, 2931, 2965, 3056, 3069, 3084, 3117, 3118, 3129, 3131, 3134, 3135, 3137, 3140, 3141, 3146, 3149, 3151, 3168, 3170, 3173, 3509

2706 (GEAP—11367) **Appraisal of BWR plutonium burners for energy centers.** Williamson, H.E. (General Electric Co., San Jose, Calif. (USA)). Jan 1976. Contract AT(04-3)-189. 142p. Dep. NTIS $6.00.

The design of BWR cores with plutonium loadings beyond the self-generation recycle (SGR) level is investigated with regard to their possible role as plutonium burners in a nuclear energy center. Alternative plutonium burner approaches are also examined including the substitution of thorium for uranium as fertile material in the BWR and the use of a high-temperature gas reactor (HTGR) as a plutonium burner. Effects on core design, fuel cycle facility requirements, economics, and actinide residues are considered. Differences in net fissile material consumption among the various plutonium-burning systems examined were small in comparison to uncertainties in HTGR, thorium cycle, and high plutonium-loaded LWR technology. Variation in the actinide content of high-level wastes is not likely to be a significant factor in determining the feasibility of alternate systems of plutonium utilization. It was found that after 10,000 years the toxicity of actinide high-level wastes from the plutonium-burning fuel cycles was less than would have existed if the processed natural ores had not been used for nuclear fuel. The implications of plutonium burning and possible

future fuel cycle options on uranium resource conservation are examined in the framework of current ERDA estimates of minable uranium resources.

2707 (NEDO—20939) **Lattice physics methods verification. Licensing topical report.** Martin, C.L. (General Electric Co., San Jose, Calif. (USA). BWR Projects Dept.). Jun 1976. 50p. Dep. NTIS $4.00.

The GE Lattice Physics System was developed to be the principal reactor-physics design tool for BWR's. It has been extensively compared against experiments and has shown significant improvement over the previous design codes. This report documents many of the experimental comparisons made.

2708 (NUREG—0081) **Evaluation of the integrity of reactor vessels designed to ASME Code, Sections I and/or VIII.** Hoge, K.G. (Nuclear Regulatory Commission, Washington, D.C. (USA). Office of Nuclear Reactor Regulation). 11 Jun 1976. 67p. NTIS $4.50.

A documented review of nuclear reactor pressure vessels designed to ASME Code, Sections I and/or VIII is made. The review is primarily concerned with the design specifications and quality assurance programs utilized for the reactor vessel construction and the status of power plant material surveillance programs, pressure-temperature operating limits, and inservice inspection programs. The following ten reactor vessels for light-water power reactors are covered in the report: Indian Point Unit No. 1, Dresden Unit No. 1, Yankee Rowe, Humboldt Bay Unit No. 3, Big Rock Point, San Onofre Unit No. 1, Connecticut Yankee, Oyster Creek, Nine Mile Point Unit No. 1, and La Crosse.

2709 Operating experience with Swiss nuclear power plants. Wuethrich, H.; Spaargaren, B. *Brown Boveri Rev.*; 3-7([nd]).

Operational experience is summarized for the Muehleberg nuclear power plant (BWR) and the Beznau nuclear power plant (PWR). Included are plant specifications and availability data. (DG)

2710 A channel box for water cooled nuclear reactors, and reactor core comprising same. Dupuy, G.; Remoleur, J.; Schwartz, J.P. (to CEA, 75 - Paris (France)). French Patent 2243495/A/. 6 Sep 1973. 13p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France).

The channel box described is characterized in that it is constituted by several similar modules of prismatic shape, inside each of which are vertically mounted one or several fuel element bundles which are not integral with said module, the walls of said channel box being provided with means for guiding control rods, means adapted to provide emergency coolant and means for positioning measuring devices. This can be applied to light water reactors.

2711 A resilient locking device for nuclear fuel bundles. Curulla, M.V.; Smith, B.A.; Ashton, J.A. (to General Electric Co., Schenectady, N.Y. (USA)). French Patent 2243496/A/. 11 Sep 1974. 12p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France); priority claim: 12 Sep 1973, USA.

A description is given of a device wherein a spring and an abutment are maintained captive on a retaining screw. That device comprises a spring provided with at least one blade-shaped resilient portion and with an upper portion comprising an unthreaded hole, an abutment, a screw provided with a head, an intermediate stem portion and a threaded end-portion the diameter of which is higher than that of said intermediate stem portion, said spring and abutment being maintained trapped on said intermediate stem portion through the deformation of adjacent threads of said threaded end-protion of the screw and of the threaded hole of the abutment upper portion, in order to prevent said members from being separated.

2712 Acoustic emission as an inspection method for nuclear reactor vessels. Eisenblaetter, J.; Heide, W.; Jax, P.; Joest, H.; Klot, R.v. (Battelle-Institut e.V., Frankfurt am Main (F.R. Germany)). pp 168-175 of In Periodic inspection of pressurized components. A conference arranged by the Applied Mechanics Group and the Nuclear Energy Group of the Institution of Mechanial Engineers, London, 4-6 June 1974. London; Mechanical Engineering Pub. for Institution of Mechanical Engineers (1975).

From Conference on periodic inspection of pressurized components; London, UK (4 Jun 1974).

Various sources of acoustic emissions (e.g. plastic deformation, crack propagation during cyclic and normal tensile loading, friction at the crack tip during fatigue loading) are listed and the differences between the various types of acoustic emission are discussed in detail. A quantitative correlation between the rate of crack propagation and the rate of acoustic emission has been established. Acoustic emission was evaluated during hydrostatic proof tests of large vessels, and during the different operating phases of light-water nuclear reactors. Particle loss in steam generator was indicated by increasing levels of high-frequency noise.

2713 Requirements for in-service inspection of water-cooled reactor vessels by nondestructive testing methods in Germany. Trumpfheller, R. (Rheinisch-Westfaelischer Technischer Ueberwachungs-Verein e.V., Essen (F.R. Germany)). pp 114-117 of In Periodic inspection of pressurized components. A conference arranged by the Applied Mechanics Group and the Nuclear Energy Group of the Institution of Mechanical Engineers, London, 4-6 June 1974. London; Mechanical Engineering Pub. for Institution of Mechanical Engineers (1975).

From Conference on periodic inspection of pressurized components; London, UK (4 Jun 1974).

In-service inspection requirements have been set up case by case by licensing authorities. In general, it must be possible to inspect the entire pressure vessel wall visually and by means of ultrasonic methods. Exceptions are admitted for small areas with slight stress only. Welding seams, ligaments between the holes for the control rod penetrations, inner edges of the coolant nozzles, and bolts and nuts are to be inspected periodically without exception. Further requirements dealing with ultrasonic techniques (e.g. calibration of beam angles and echo amplitudes) are based upon previous experiences and should ensure a satisfactory testing sensitivity.

2714 Automated ultrasonic examination of light water reactor systems. Walter, J.H. (Rockwell International Corp., El Segundo, Calif. (USA)). pp 66-71 of In Periodic inspection of pressurized components. A conference arranged by the Applied Mechanics Group and the Nuclear Energy Group of the Institution of Mechanical Engineers, London, 4-6 June 1974. London; Mechanical Engineering Pub. for Institution of Mechanical Engineers (1975).

From Conference on periodic inspection of pressurized components; London, UK (4 Jun 1974).

An automated ultrasonic examination system has been developed to meet the pre- and inservice inspection requirements of light water reactors. This system features remotely-controlled travelling instrument carriers, computerized collection and storage or inspection data in a manner providing real time comparison against code standards, and computer control over the positioning of the instrument carriers to provide precise location data. The system is currently being utilized in the field for a variety of reactor inspections. The principal features of the system and the recent inspection experience are discussed.

2715 Nuclear fuel rod with predetermined breaking point. Schlenker, L.D. (to Energy Research and Development Administration, Washington, D.C. (USA)). German(FRG) Patent 2439478/A/. 27 Feb 1975. 9p. (In German).

4 figs.

The invention described claims a method to prevent the swelling of the fuel rods of a water-cooled reactor during a loss-of-coolant accident which may block the coolant channel so that the reliable performance of the emergency cooling system is endangered. The author proposes a fuel can design incorporating a mechanically weak point in such a way that, e.g., the fuel can is thinner at the predetermined breaking point than at all other points of the fuel rod. He also makes suggestions as to where the predetermined breaking point should be most advantageously located in order to increase the probability of a reliable performance of the emergency core cooling system.

2716 Energy generation in light water reactors. Keller, W. (Kraftwerk Union A.G., Erlangen (F.R. Germany). Reaktortechnik). *Atomwirtsch., Atomtech.*; **20**: No. 10, 476-482(Oct 1975). (In German).

From Reactor conference; Nuernberg, F.R. Germany (8 Apr 1975).

11 figs.; 3 refs.

Very positive operating experience has been accumulated over the past few years with nuclear power stations equipped with light water reactors. Especially the reliability, availability and the non-polluting properties of these plants have been demonstrated over prolonged periods of time. If one looks at the energy reserves, one clearly realizes that in the long run only nuclear power is able to ensure the energy supply of the industrialized countries. In the medium term, the use of the waste heat from nuclear power stations for district heating and industrial heating purposes is an aspect of major importance. Despite considerable price increases experienced over the past few years, nuclear power stations equipped with light water reactors have retained their economic superiority over all other thermal power stations. Also analyses of the availability and nuclear safety show very satisfactory results.

2717 Operating results of the nuclear power stations and nuclear electricity generation in the European Community for 1974. *Atomwirtsch., Atomtech.;* **20**: No. 11, 582-584(Nov 1975). (In German).

2 figs.; 3 tabs. Short communication only.

2718 Cooling nuclear reactor fuel. Porter, W.H.L. (to UKAEA). British Patent 1,414,305/B/. 19 Nov 1975. 4p.

Reference is made to cluster type reactors in which the fuel is cooled by water, steam or a two phase mixture of water and steam. According to current practice the coolant is passed axially through the cluster in an upward direction. It has been proposed that in addition to the main axial coolant flow a supply of coolant, auxiliary to the main coolant, be provided so as to pass laterally into the cluster or sprayed over the top of the cluster. This auxiliary supply would usually be held in reserve, ready to be brought into effect should the main coolant system prove inadequate or ineffective for some reason. Means are provided for varying the positions of impingement. An oscillatory motion is imposed on fluid in the main coolant flow path within the cluster by a pulsator that generates a series of pressure waves at a local region within the cluster, the effect of which is transmitted through the main coolant to momentarily deflect thejets of auxiliary coolant. An auxiliary coolant conduit may be provided that can oscillate under the pressure of the auxiliary coolant.

2719 Neutron noise in boiling water reactors. van Dam, H. (Interuniversitair Reactor Instituut, Delft (Netherlands)). *Atomkernenergie;* **27**: No. 1, 8-14(1976).

9 figs.; 10 refs.

A description is given of a method to calculate the response of neutron detectors to parametric fluctuations in a reactor core. This method is based on perturbation theory and is used to calculate auto-power spectral densities and cross-power spectral densities (CPSD) of steam bubble noise in a boiling water reactor. Transport of steam bubbles in the core gives rise to some characteristic features in the calculated CPSD's, which have also been found in experiments: dips in the modulus-to-frequency diagram and oscillations in the phase-to-frequency diagram. It is shown that these characteristics depend on the ratio of the local sensitivity to the global sensitivity of the neutron detector. These sensitivities depend on both the core composition and the detector properties.

2720 Smoothing procedures for neutron flux distribution measurements in a boiling water reactor. Kostic, L. (Eidgenoessisches Inst. fuer Reaktorforschung, Wuerenlingen (Switzerland)). *Atomkernenergie;* **27**: No. 1, 15-17(1976).

4 figs.; 4 refs.

A calculation procedure for restoring noise-contaminated functions is presented. The method is based on the use of a digital filtering technique in the time domain with the help of algorithms based on low-pass filters and on combinations of two low-pass filters. To demonstrate both the necessity and the usefulness of such a technique in practice, the method is applied to an experimental example.

2721 Construction and operating experience with light water reactors - Oskarshamn. *Nucl. Eng. Int.;* **21**: No. 238, 53-56(Jan 1976).

The progress and construction and operating experience at Sweden's nuclear power stations is described. Sweden has five units currently operating including four BWRs, two at Oskarshamn, one at Barsebaeck and one at Ringhals, and also a PWR, at Ringhals. Apart from the usual delays encountered in commissioning nuclear plant, particular difficulties were encountered with turbines and generators. Under construction are two more PWR units at Ringhals, a second BWR unit at Barsebaeck, and two BWR units at Forsmark.

2722 Outlook for ASEA-Atom and Sweden's nuclear industry. Halle, L. (ASEA-Atom). *Nucl. Eng. Int.;* **21**: No. 238, 35-38(Jan 1976).

Using independently developed technology, ASEA-Atom have completed four BWR power station units and have five more under construction. Some features of their already-commissioned stations have since been incorporated in other manufacturers' designs to meet increased safety requirements. Primarily an engineering company with the ability to develop, design and construct nuclear power plants, the company's own manufacturing activities are limited to fuel-fabrication including UF_6 conversion and special in-core components. Special features of the company should make its products attractive to export markets.

2723 Chemistry of feedwater for boiling-water and pressurized-water reactors. Bodmer, M.; Svoboda, R. *Brown Boveri Rev.;* **63**: No. 1, 42-49(Jan 1976).

In a nuclear power plant the purity of the feedwater depends largely on whether a condensate polishing plant is provided, whether the loop is conditioned and on the presence of corrosion products originating in the materials from which the loop is made. The feedwater specification depends on the type of steam generator used. The article defines the characteristic parameters of a condensate polishing plant (CPP), such as the 'degree of polishing' and 'practical exchange capacity of the resins' and indicates how they can be determined. In pressurized-water reactors (PWR) the feedwater is normally conditioned with hydrazine. Measurements are quoted to demonstrate that, in contrast to conventional plants, the point of injection is immaterial as regards the copper content of the feedwater. Moreover, the iron content of the feedwater of a PWR can be reduced by using cyclic amines. The feedwater chemistry of a BWR is discussed by referring to oxygen, iron and copper measurements. The authors show that in loops in which the feed-heater condensate is pumped forwards and where a feedwater tank is provided, the stipulated purity of the feedwater can be attained by suitable measures (such as mechanical filtration, prevention of erosion-corrosion, and so on).

2724 Moisture separator/reheater for saturated-steam turbines. Lang, H.; Sonnenmoser, A. *Brown Boveri Rev.;* **63**: No. 1, 66-75(Jan 1976).

In nuclear power plants with light-water reactors the steam at the end of the expansion in the h.p. turbine has a wetness of 10...15%. In order to avoid blade erosion and efficiency losses in the l.p. turbine, this steam is dried and superheated by live steam, following its expansion in the h.p. turbine. Both these operations are carried out in the moisture separator/reheater. After a quick glance at the development in this field, a new concept for a moisture separator/reheater is described. This gives aspects of the design, thermodynamics and operation.

2725 Graben 1200 MW nuclear power plant. Scharff, W.; Sonin, J.; Riolo, H. *Brown Boveri Rev.;* **63**: No. 1, 54-65(Jan 1976).

Initially the evolution of the nuclear power plant and the conditions pertaining to the Graben site are outlined. Then, some design criteria, the layout plan, major parts of plant and some of the systems are discussed. The equipment serving the safety of the nuclear power plant can still be subject to certain alterations. This is because the procedure concerning construction permission is currently being worked on. In this article therefore this equipment is handled in a general way.

2726 Operating experience with Swiss nuclear power plants. Wuethrich, H.; Spaargaren, B. *Brown Boveri Rev.;* **63**: No. 1, 17-21(Jan 1976).

The present article is a summary of the experience gained from operation of the nuclear power plants Muehleberg (with boiling-water reactor) and Beznau (with pressurized-water reactor), which commenced regular service between 1969 and 1972. These plants, with rated outputs of 300 and 350 MW(e), respectively, exhibit an availability which compares very well with the performance of other nuclear plants all over the world. This good result may be attributed, not only to the successful efforts of the station staff, but also to the close cooperation between the power companies concerned and the contractors.

2727 Off-gas systems for nuclear power plants with boiling-water reactors. Macekovic, M. *Brown Boveri Rev.;* **63**: No. 1, 50-53(Jan 1976).

Today the emission of radioactive off-gas from nuclear power plants permitted by the authorities is limited to very low levels. The off-gas treatment process used by Brown Boveri for different operational conditions guarantees a safe discharge of radioactive gases, whilst at the same time observing the restrictions set by the authorities.

2728 Control of impurities in the circulating water in pressurised and boiling water reactors. Bodmer, M. (Brown, Boveri and Co. Ltd., Baden (Switzerland)). *Technica (Basel);* **25**: No. 5, 279-282(5 Mar 1976). (In German).

Experience on the Muehleberg and Oskarshamn nuclear power stations with respect to salt, acid and oxygen concentrations in the cooling water is described. The two cases of salty coolant taken from the sea, and of re-used coolant condensed in cooling towers are examined. The life and performance of filter beds of two types are compared and the activity of the coolant due to leakage repairs and emergency shutdowns is considered. It is recommended that coolant contamination be thoroughly examined in reactors already operational. The point is made that low alloy steel corrodes less in water carrying some oxygen than in oxygen-free water, whereas brass cannot tolerate oxygen. It is concluded that filter beds are the correct answer where salt concentration is high and that titanium is not, at the present time, cost effective.

2729 **What it takes to get nuclear power plants built.** Markvartova, E. *Jad. Energ.;* **22**: No. 4, 149-152(Apr 1976). (In Czech).

After "Nuclear Power Plants: What it takes to get them built" by Ramesh, N. Budwani in Power Engineering (1975), v. 79(6) p. 39-45.

The results are reported of a study analyzing the need for labor and materials, the indices of work productivity, and the time required for constructing typical boiling water and pressurized water reactor nuclear power plants built in the USA between 1960 and 1980.

2730 **Investigations of an in-core anomaly in an operating BWR.** Harris, R.T. (Northeast Utilities Service Co., Hartford, CT). *Trans. Am. Nucl. Soc.;* **23**: 464-465(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2731 **Detection of impacts of instrument tubes against channel boxes in BWR-4s using neutron noise analysis.** Mott, J.E. (Univ. of Tennessee, Knoxville); Robinson, J.C.; Fry, D.N.; Brackin, M.P. *Trans. Am. Nucl. Soc.;* **23**: 465(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2732 **Neutron noise measurements to evaluate BWR-4 core modification to prevent instrument tube vibration.** Mathis, M.V. (Oak Ridge National Lab., TN); Fry, D.N.; Robinson, J.C.; Jones, J.E. *Trans. Am. Nucl. Soc.;* **23**: 466(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2733 **Determination of void fraction in BWRs using neutron noise analysis.** Atta, M.A. (Inst. of Nuclear Science and Technology, Pakistan); Mott, J.E.; Fry, D.N. *Trans. Am. Nucl. Soc.;* **23**: 466-468(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2734 **Neutronic correlation of BWR TIP noise.** Cheng, H.S.; Diamond, D.J. (Brookhaven National Lab., Upton, NY). *Trans. Am. Nucl. Soc.;* **23**: 469-470(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2735 **Importance of void geometry representation for plutonium recycle analysis in boiling water reactors.** Stillwagon, G.B.; Carlson, R.W. (Georgia Inst. of Tech., Atlanta). *Trans. Am. Nucl. Soc.;* **23**: 536-537(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2736 **Simple method for adjoint thermal spectrum calculation and its application.** Lu, M.S.; Cheng, H.S.; Diamond, D.J. (Brookhaven National Lab., Upton, NY). *Trans. Am. Nucl. Soc.;* **23**: 538(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, NON-BOILING WATER COOLED

REFER ALSO TO CITATION(S) 2708, 2709, 2710, 2711, 2712, 2713, 2714, 2715, 2716, 2717, 2718, 2721, 2723, 2726, 2728, 2729, 2736, 2902, 2910, 2912, 2922, 2923, 2927, 2928, 2930, 2931, 2965, 3060, 3067, 3117, 3118, 3119, 3120, 3121, 3122, 3123, 3124, 3131, 3139, 3140, 3141, 3146, 3148, 3149, 3151, 3157, 3168, 3230, 3231, 3233, 3234, 3235, 3241, 3242, 3246, 3509

2737 (AED-CONF—75-470-001) **The straight-tube once-through steam generator in the BBR reactor. Design and experience gained so far.** Jeglic, F.A.; Wietelmann, W.F. (Babcock - Brown Boveri Reaktor G.m.b.H., Mannheim (Germany, F.R.)). 1975. 21p. (In German). (CONF-7510126—1). INIS.

From VGB symposium) steam boilers and steam boiler operation; Koeln, German, Federal Republic of (F.R. Germany) (17 Oct 1975).

10 figs.

The steam generator used with a pressurized-water reactor in the BBR steam generation system exhibits a new economical construction as a straight-tube type with once-through steam generation. Construction, fabrication, research programmes and operational experience of this straight-tube steam generator are explained in this lecture.

2738 (NP—20881) **Examinations of portions of the reactor building spray system piping from the Arkansas Nuclear Plant No. 1.** Berry, W.E.; Stiegelmeyer, W.N.; Boyd, W.K. (Battelle Columbus Labs., Ohio (USA)). 7 Feb 1975. 29p. NRC.

An examination has been made of a cracked welded joint from the 10-inch Type 304 stainless steel piping in the recirculating line of the Reactor Building Spray System in the Arkansas Nuclear Plant No. 1. Cracks were observed at six joints within an 8-day period after the system was operated for 6 to 7 months with H_3BO_3 (2300 ppm B) at ambient temperature. Chemical analyses revealed the piping was within chemical specifications for Type 304 stainless steel. Metallographic examination revealed stress-corrosion cracking that initiated on the inside surface of the pipe and propagated intergranularly through the sensitized microstructure (chromium carbide precipitation at grain boundaries) of the heat-affected zone adjacent to the weld. Microprobe and scanning electron microscope analyses revealed up to 1000 ppm chlorine on the tarnish film at the heat-affected zone on the inner surface of the pipe as well as areas of chlorine on the fracture surface itself. Also found at the heat-affected zone were appreciable quantities (to 1 percent) of sodium, aluminum, silicon, calcium, magnesium, potassium, and titanium. Activity analyses revealed Co-58 and Fe-59 deposits on the surface which were transported from elsewhere in the system. Examination of radiographs from several sources revealed that the cracks coincided with areas of weld repair or high heat input and thus were caused by high residual stresses from welding. Chloride ion was the probable corrodent. Its source is not known definitely, but the chloride could have become concentrated by an ion-exchange process on the tarnish film at the heat-affected zone even from a bulk solution concentration of less than 100 ppb. Aluminum corrosion products (as found in this area) would contribute to this concentrating mechanism.

2739 (RD/B/N—3239) **Results of burnup measurements on two assemblies from Beznau 1 (PWR).** Dawson, J.T. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). Jun 1975. 30p. INIS.

A total of 36 pins from assemblies 58 and 80, discharged at the end of the first operating cycle of the PWR Beznau Unit 1, were gamma scanned using a high resolution Ge(Li) detection system to measure axial and pin-to-pin burn-up distributions. Relative burn-ups determined independently from the measured concentrations of the fission products ^{137}Cs and ^{144}Ce mutually agreed to +-1%(1sigma). Good agreement was also obtained with mass spectrometry measurements carried out at Harwell on a few sample pellets. The measurements demonstrated that the Westinghouse predictions of relative pin-to-pin burn-up (i.e. those available to the reactor operator) were accurate to within +-1.4%(1sigma) throughout both assemblies, with no significant effect from one assembly to the other. Absolute pin burn-ups were deduced from a combination of the gamma scanning and Harwell mass spectrometry results. The corresponding Westinghouse estimates (with the pin-to-pin fine structure errors removed) agreed with experiment to within the combined measurement uncertainties of less than +-3%(1sigma). Local burn-up peaks of up to (9+-1)% were observed in fuel adjacent to collapsed cladding in a neighbouring pin. It was shown that previous measurements of this peaking made on a simple NaI detection system should be reduced by a scaling factor of 0.83.

2740 **Monitoring of the effect of irradiation on steel in PWR vessels and its consequences.** Quero, J.R.; Raoul, J.P. (Societe Franco-Americaine de Constructions Atomiques (FRAMATOME), 92 - Courbevoie (France)). pp 415-435 of In Facteurs mechaniques et metallurgiques de la rupture, notamment dans l'industrie nucleaire. Saclay, France; Institut National des Sciences et Techniques Nucleaires (1975). (in French)

From 17. Colloquium on metallurgy. Mechanical and metallurgical factors of fracture, particularly in nuclear industry; Saclay, France (24 Jun 1974).

The integrity of reactor vessels is an important factor governing the safety of light water reactors, and it is well known that irradiation significantly affects the mechanical properties of steels. This effect is taken into account in designing installations, to ensure their operation for 40 years without any risk of sudden fracture of the vessel. However, in order to confirm the validity of initial studies, it is important to monitor each vessel for the effects of irradiation on the toughness of the steel employed. The method employed, planned experimental arrangements, and the potential

consequences of the results obtained on subsequent operation of the installation are described.

2741 (ERDA-tr—125, pp 119-126) **Spectral composition of the radiation on the premises of the Novo-Voronezhskaya AES's second unit.** Glushchenko, A.I.; Orlov, Yu.V.; Satarin, V.E. 1974. Translated from pp 93-98 of Voprosy fiziki zashchity reaktorov, vypusk 6, Atomizdat, Moscow, 1974.

In Questions on the physics of reactor shielding. Volume 6.

Results of measurements of neutron spectra at various points in the Novo Voronezh-2 Reactor building are presented.

2742 A method for reducing gas concentration in a nuclear reactor. Marchese, R.T. (to Westinghouse Electric Corp., Pittsburgh, Pa. (USA)). French Patent 2,238,217/A/. 15 Jul 1974. 8p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France); priority claim: 16 Jul 1973, USA.

The invention relates to a method for reducing the concentration of dissolved radioactive gases in a reactor primary coolant circuit. Gas concentration in the coolant is first increased by adding a stable gas of the same type; the radioactive gases and the stable gas are eliminated jointly until a low concentration is achieved. The remaining low gas concentration mainly consists of stable gas, and a very small amount of radioactive gases is left in the coolant.

2743 Heat exchanger with dual tubes. Mangus, J.D. (to Westinghouse Electric Corp., Pittsburgh, Pa. (USA)). French Patent 2,241,759/A/. 21 Aug 1974. 14p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France); priority claim: 21 Aug 1973, USA.

The invention relates to a heat exchanger provided with dual tubes arranged in two bundles within a casing. The heat exchanger is characterized in that the tubes penetrate into the casing from the opposite ends thereof, the tubes being imbricated in such a way of the second bundle, a heat-conducting medium being contained in the casing for transferring heat from the fluid of one of the bundles to the other bundle fluid. The invention can be applied in particular to liquid-metal steam generators and also extended to PWR reactors.

2744 Influence of temperature and primary coolant in a light water reactor on the fatigue strength of Z4CND18-12 steels. Rabbe, P.; Amzallag, C. (Societe Creusot-Loire, 42 - Firminy (France)); Roul, J.P. (Societe Franco-Americaine de Constructions Atomiques (FRAMATOME), 92 - Courbevoie (France)). pp 677-707 of In 17. Colloquium on metallurgy. Mechanical and metallurgical factors of fracture, particularly in nuclear industry. Saclay, 24-26 June 1974. Saclay, France; Institut National des Sciences et Techniques Nucleaires (1975). (In French)

From 17. Colloquium on metallurgy. Mechanical and metallurgical factors of fracture, particularly in nuclear industry; Saclay, France (24 Jun 1974).

The relatively severe operating conditions prevailing in the primary coolant circuits of light water nuclear power stations have given rise to concern about cracks liable to occur in service. Repeated tensile tests were performed (R=0) with compact type specimens at room temperature (in air) and at 320 deg C (in air and in the primary coolant). The main conclusions are presented.

2745 The ultrasonic shop map and its use in preservice inspection. Caplan, J.S. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). PWR Systems Div.). pp 19-28 of In Periodic inspection of pressurized components. A conference arranged by the Applied Mechanics Group and the Nuclear Energy Group of the Institution of Mechanical Engineers, London, 4-6 June 1974. London; Mechanical Engineering Pub. for Institution of Mechanical Engineers (1975).

From Conference on periodic inspection of pressurized components; London, UK (4 Jun 1974).

Prior to the introduction of Section X1 of the ASME Code on Inservice Inspection, a plan was introduced by Westinghouse to perform ultrasonic examinations of areas of high stress and high fluence of reactor pressure vessels in the manufacturer's shop and subsequent to the shop hydrostatic test. The tests provided a shop reference map of ultrasonic responses to use in subsequent preservice and inservice inspections, and attempted to locate any ultrasonic reflections beyond the acceptance standards of ASME Section III and, later, of Section X1. The history of the program is reviewed. Thirty-six vessels were examined during 1970 to 1973. As a result of indications discovered during ultrasonic examination repairs were carried out on five of these. Details are given of inspections and repairs. A summary is also given of the indications detected and of the correlations between the ultrasonic evaluation and actual flow characteristics.

2746 Acoustic emission monitoring system evaluation at Prairie Island. Gopal, R. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Nuclear Energy Systems Div.). pp 162-167 of In Periodic inspection of pressurized components. A conference arranged by the Applied Mechanics Group and the Nuclear Energy Group of the Institution of Mechanial Engineers, London, 4-6 June 1974. London; Mechanical Engineering Pub. for Institution of Mechanical Engineers (1975).

From Conference on periodic inspection of pressurized components; London, UK (4 Jun 1974).

Recent advances in instrument systems for detection, location and display of acoustic emission sources in nuclear power plants are described. Results are discussed of measurements and system performance during hydrostatic testing, hot functional tests and pre-critical operations at Prairie Island nuclear power plant.

2747 Component modifications and technique developments resulting from inservice inspection experience on pressurized water reactors. Katz, L.R. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Nuclear Energy Systems Div.). pp 12-18 of In Periodic inspection of pressurized components. A conference arranged by the Applied Mechanics Group and the Nuclear Energy Group of the Institution of Mechanical Engineers, London, 4-6 June 1974. London; Mechanical Engineering Pub. for Institution of Mechanical Engineers (1975).

From Conference on periodic inspection of pressurized components; London, UK (4 Jun 1974).

Preservice and inservice inspection of PWR coolant systems during the pre-compliance period of ASME Code Section X1 provided valuable information relating to component design changes and modifications to plant arrangement required for complete compliance. Deficiencies related to accessibility for inspection, component design problems, surface finish and the need for new techniques and equipment. The advantages leading to the choice of inside inspection of PWR vessels are described and modifications which can be made to customer requirements for external inspection are illustrated. Component design considerations which are discussed includes changes in nozzle design to allow access for nozzle to pipe weld inspection and improved surface finish on both welds and adjacent material. A new remotely operated tool designed, manufactured and tested for periodic inservice volumetric inspection of the pressure vessel is described. Details are also given of a refracted longitudinal ultrasonic method for inservice inspection of stainless steel castings and special radiographic techniques applied to 'electroslag' type of welds.

2748 Routine checkout. Saglio, R. (French Atomic Energy Commission). pp 139-145 of In Periodic inspection of pressurized components. A conference arranged by the Applied Mechanics Group and the Nuclear Energy Group of the Institution of Mechanical Engineers, London, 4-6 June 1974. London; Mechanical Engineering Pub. for Institution of Mechanical Engineers (1975).

From Conference on periodic inspection of pressurized components; London, UK (4 Jun 1974).

Problems encountered in continued ultrasonic inspection of PWR pressure vessels and the influence of cladding, vessel shape, grain size of dissimilar metal welds, and type of transducers used are discussed. The solutions proposed to some of these problems, for the inspection of girth-seam welds, spherical head welds, nozzles, safe ends upper flanges, studs and nuts, and the cover, are described. A description is given of the equipment developed for inspection of a PWR vessel from the inside with details of each subassembly and its function.

2749 An inspection technique for nuclear reactor vessels using an electrical resistance probe. Yamaguchi, T.; Fukushima, Y.; Fukue, H. (Mitsubishi Heavy Industries Ltd., Kobe (Japan). Kobe Technical Inst.). pp 100-107 of In Periodic inspection of pressurized components. A conference arranged by the Applied Mechanics Group and the Nuclear Energy Group of the Institution of Mechanical Engineers, London, 4-6 June 1974. London; Mechanical Engineering Pub. for Institution of Mechanical Engineers (1975).

From Conference on periodic inspection of pressurized components; London, UK (4 Jun 1974).

An in-service inspection technique, using an electrical resistance probe, for the PWR type of nuclear reactor vessel inner surface, which has been developed by Mitsubishi Heavy Industries, Ltd (MHI) is described. The equipment consists of the resistance probe, an automatic remote-contolled mechanism, and a data acquisition system. The mock-up test resulted in satisfactory data on various test features: the reproducibility of position control, the ability to measure defect sizes, and inspection in a continuous scanning mode.

2750 Separators-superheaters of turbines for nuclear power plants. Bessouat, R. (Societe Stein Industrie, 75 - Paris (France)). *Tech. Mod.*; **67**: No. 7, 34-37(Jul 1975). (In French).

Separators-superheaters are developed within the framework of the French construction project of nuclear turbines. Operating mode, design and industrial fabrication are described.

2751 PWR reactors in France. Leny, J.C. (Societe Franco-Americaine de Constructions Atomiques (FRAMATOME), 92 - Courbevoie (France)). *Rev. Gen. Nucl.*; **1**: No. 3, 194-207(Jul 1975). (In French).

The characteristics of the PWR reactors are reported and the main factors which from the viewpoint of reliability have led to the commercial development of these reactors are presented. The methods used in France by the manufacturers of PWR reactors in order to fill the contracts given out by the Public Authorities are described. The technical improvments which can be made in France are recalled.

2752 Buildings of Electricite de France nuclear power plants. *Tech. Mod.*; **67**: No. 10, 13-15(Oct 1975). (In French).

Some general views are given about construction of reactor buildings and auxiliary buildings of French 900MW PWR nuclear power plants.

2753 Neutron physics study of a water cooled pebble bed reactor. Heindler, M. (Technische Hochschule, Graz (Austria). Inst. fuer Theoretische Physik und Reaktorphysik). *Atomwirtsch., Atomtech.*; **20**: No. 11, 574-580(Nov 1975). (In German).

6 figs.; 3 tabs.; 29 refs.

Because of the advantages of pebble bed reactors, which have been proven in practical application for high temperature gas cooled reactors, attempts have been carried on for a long time to use spherical fuel elements also in reactors operated with liquid coolants. The core concepts of the pebble bed reactors so far built are briefly outlined. From the results of the studies it appears to be possible that even in the case of reactors with liquid coolants the pebble bed core concept could turn out to be an interesting alternative to conventional concepts. In the parameter study whose results are mentioned in the report, a 907 MW(t) pressurized water reactor with spherical fuel elements is described. The study is concerned exclusively with problems relating to the choice of the coolant. After an introduction of the computer models, the neutron physics characteristics of the reactor configuration and the thermodynamic conditions in the core are investigated. The burnup behavior was calculated for a specific reactor power. Attention is drawn to some unsolved problems.

2754 First recurring inspection of the primary circuit of the WWER-2 reactor in the Rheinsberg nuclear power plant. Pastor, D.; Keil, H. (VEB Kernkraftwerk Bruno Leuschner, Greifswald (German Democratic Republic). Betriebsteil Kernkraftwerk Rheinsberg). *Kernenergie;* **19**: No. 3, 83-86(1976). (In German).

During the second stage of the inspection program for the primary circuit a recurring inspection was performed in the period from 1972 to 1973. The extent of inspection, nondestructive testing methods used, and the results of the inspection are presented. Apart from some technological problems, such as decontamination, re-insulation and radiation doses, testing problems are particularly dealt with. Finally, it is stated that the primary circuit of the WWER-2 reactor is in a safe state.

2755 Nuclear power plant in Muelheim-Kaerlich. Charisius, J. *Brown Boveri Rev.*; **63**: No. 1, 76-77(Jan 1976).

Muelheim-Kaerlich nuclear power plant is being built on a turnkey basis by the consortium composed of Brown Boveri and Cie. AG, Mannheim (BBC), Babcock-Brown Boveri Reaktor GmbH, Mannheim (BBR) and Hochtief AG, Frankfurt/Main under contract from the Rheinisch-Westfaelisches Elektrizitaetswerk (RWE) of Essen.

2756 Pressurized water reactor effluent discharge trends in the United States. Gruhlke, J.M. (Environmental Protection Agency, Washington, DC). *Trans. Am. Nucl. Soc.*; **23**: 86-87(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2757 Seismic qualification of main steam safety valves. Lai, Y.S. (Dresser Industries, Inc., Alexandria, LA). *Trans. Am. Nucl. Soc.*; **23**: 399(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2758 Good management of available resources will improve nuclear plant reliability. Herbein, J.G. (Metropolitan Edison Electric Co., Middletown, PA). *Trans. Am. Nucl. Soc.*; **23**: 405-406(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2759 Vendor's contribution to sustained nuclear steam supply system operation. Kennedy, J.P. (Babcock and Wilcox Co., Lynchburg, VA). *Trans. Am. Nucl. Soc.*; **23**: 406-407(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2760 Nuclear power plant standardization: reference plant design. Kennedy, J.L.; Schultz, B.G.; Morse, A.; . (Stone and Webster Engineering Corp., Boston, MA). *Trans. Am. Nucl. Soc.*; **23**: 423-424(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2761 Determination of core barrel motion from the neutron noise spectral density data-scale factor. Robinson, J.C. (Oak Ridge National Lab., TN); Shahrokhi, F. *Trans. Am. Nucl. Soc.*; **23**: 458-459(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2762 Calculation of spatial weighting function for ex-core detectors. Crump, M.W.; Lee, J.C. (Univ. of Michigan, Ann Arbor). *Trans. Am. Nucl. Soc.*; **23**: 461-462(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2763 Quarter-core flux mapping-power distribution measurement technique for non-safety-state conditions in Westinghouse PWR cores. Jones, K.A.; Kerr, R.A. (Westinghouse Electric Corp., Pittsburgh). *Trans. Am. Nucl. Soc.*; **23**: 481(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2764 Dynamic behavior of the B and W nuclear steam system. Galan, V.J.; Russell, C.D. (Babcock and Wilcox Co., Lynchburg, VA). *Trans. Am. Nucl. Soc.*; **23**: 488-489(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

POWER REACTORS, NON-BREEDING, GRAPHITE MODERATED

2765 (GA-A—13825) Migration of $(Th,U)C_2$ fuel kernels. Sims, J.R. Jr.; Smith, C.L.; Scott, C.B. (General Atomic Co., San Diego, Calif. (USA)). 3 May 1976. Contract E(04-3)-633. 40p. Dep. NTIS $4.00.

Mixed carbide [$(Th/U)C_2$] fuel kernels for the Fort St. Vrain High-Temperature Gas-Cooled Reactor were fabricated from virgin ThO_2 and UO_2 feed stock or from a mixture of ThO_2 and U_3O_8 that was recovered from fuel kernels and coated particles rejected at various stages of the fuel fabrication process. The kernel migration behavior of "virgin" and "recovered" fuel kernels was studied by heating unirradiated coated particles containing either kernel type in a thermal gradient in order to determine kernel migration coefficients. The results of the investigation showed that kernel migration coefficient values for virgin and recovered $(Th/U)C_2$ fuel kernels are the same. The data obtained during this investigation were combined with data reported earlier to obtain a design curve for $(Th/U)C_2$ kernel migration coefficients.

2766 (GA-A—13950) Gas Turbine HTGR program. Semiannual progress report, January 1, 1976—June 30, 1976. (General Atomic Co., San Diego, Calif. (USA)). 30 Jul 1976. Contract E(04-3)-167. vp. Dep. NTIS $12.75.

Progress is reported in investigations supporting the technology for, and establishing the reference baseline design of, the helium Gas-Turbine High-Temperature Gas-Cooled Reactor (GT-HTGR). These investigations include reactor plant systems and dynamics, bottoming cycles, plant safety, primary pressure boundary, turbomachinery, helium valves and heat exchangers, fission product effects, materials, power conversion loop test alternatives, and program planning.

2767 (Juel—1198) Numerical investigations for a new refueling scheme for HTR with prismatic fuel elements under operating conditions of a helium turbine-power plant. Biele, B.

(Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Projekt Hochtemperaturreaktor mit Heliumturbinen; Technische Hochschule Aachen (Germany, F.R.)). Jun 1975. 81p. (In German). INIS.

Thesis. 45 figs.; 38 tabs.; 29 refs.

The effort to get highest gas exit temperatures with lowest fuel element temperatures in a high temperature gas-cooled reactor with prismatic fuel elements (HTGR) requires a special refueling scheme. The 'axial pushthrough' is such a refueling scheme. The neutronphysical and thermodynamic properties of an HTGR-core with pushthrough fuel management is investigated. It can be shown that a core with a high heavy metal content and pressed fuel elements (Monolith) with the geometry of the Fort St. Vrain fuel elements has the most favorable properties.

2768 (Juel—1201) **Engineering solutions for a reflector change concept in the high-temperature reactor with pebble bed core and OTTO-fueling.** Kasper, K.J. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Nukleare Sicherheitsforschung; Technische Hochschule Aachen (Germany, F.R.)). Jun 1975. 146p. (In German). INIS.

Thesis. 59 figs.; 12 tabs.; 90 refs.

In the field of reactor engineering an increasing tendency is visible towards a 'repairable reactor'. In the construction of the HTR with spherical fuel elements this fact should already be taken into account at an early stage. Additionally it is possible that in connection with the OTTO-fueling load conditions for the graphite reflector could result which are locally not far away from limiting values. Therefore the removability of the reflector is included in the reactor construction as an accompanying technical step of the physical lay-out of the core. The core arrangements, realized for HTR until recently, are discussed as well as the properties of the graphites used, and the operating conditions in the reactors are stated. Proposals are offered for the construction of a removable side and top reflector for a pebble bed reactor. Hereby a solution was found which, on one hand allows the changing of the reflector and on the other hand requires no significant increase of the costs for the reactor assembly. Moreover the requirements of reactor operation and of repairability are satisfied in an optimal manner.

2769 (Juel—1215) **The zero energy experiment KAHTER for the high temperature reactor. Construction and experimental results of phase I with homogeneous pebble bed.** Krings, F.J.; Drueke, V.; Jonas, H.; Kirch, N.; Neef, R.D.; Rueckert, M. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorentwicklung). Jul 1975. 41p. (In German). INIS.

56 figs.; 7 tabs.; 16 refs.

The critical pebble bed experiment KAHTER and the aim of the experiment are described. The experiments of phase I and their results are discussed. For comparison with calculations, the critical masses, the reactivity-worths of absorber rods and the reaction rates were measured. The influence of backscattering from the walls and a change of the filling factor of the pebble bed on the critical mass are investigated. Reactivity-worths of absorbers are determined by means of the inhour-method, the subcritical multiplication, the pulsed source measurements and the invers kinetic method. These methods are compared one with another. Special attention is paid to the dependence on the detector position. Reaction rates are measured in the thermal, epithermal, and fast energy region.

2770 (LAMS-NUREG—6231) **Multicomponent analysis of the carbon/water equilibria in the HTGR primary coolant system.** Stark, W.A. Jr.; Feber, R.C. (Los Alamos Scientific Lab., N.Mex. (USA)). Feb 1976. Contract W-7405-Eng-36. 20p. Dep. NTIS $3.50.

A thermodynamic equilibrium approach has been used to examine the limits of impurity composition of helium coolant in a high-temperature gas-cooled reactor (HTGR). Complex equilibria codes (CECs), which assume thermodynamic equilibrium and use free energy minimization techniques, have been developed to calculate coolant compositions following various amounts of steam ingress, and steam ingress in the presence of other impurities. In general, the results indicate that the most likely species, H_2, CO, and CO_2, dominate the chemistry in the coolant. Analytical treatments based on this conclusion are shown to give good agreement with CEC results. The CECs have proved useful for defining limits of coolant impurity reactions and for predicting possibly important chemical species in the HTGR coolant system.

2771 (ORNL/TM—5308) **Equipment variables and deposition conditions affecting the plasma oxidation of pyrocarbon coatings on HTGR fuel particles.** Mathers, J.P.; Tennery, V.J.; Bomar, E.S. (Oak Ridge National Lab., Tenn. (USA)). Jun 1976. Contract W-7405-eng-26. 36p. Dep. NTIS $4.00.

Selective etching with an oxygen plasma is a promising technique for revealing the structure of the high-density pyrocarbon (PyC) coatings used on HTGR nuclear fuel particles and can be used to predict the fast-neutron damage resistance of the PyC. Several factors that affect either the etching rate or the etch structure were examined in this investigation. Particles with PyC coatings deposited from hydrocarbon MAPP gas (C_3H_4 isomers) under a variety of conditions were polished to the midplane and systematically plasma oxidized to determine the effect of the coating parameters on the observed etch structure. Identical coatings were then oxidized by use of different plasma parameters to determine the relation of the observed etch pattern to these parameters. The concentration of hydrocarbon gas supplied during PyC deposition significantly affected the etch structure of the coatings. The etching rate of the PyC coating was an increasing function of the radiofrequency power used to excite the plasma and of the temperature of the coatings during the oxidation process. The plasma etching rate also appears to be related to the density of the coating (as measured by the gradient column method) and its deposition temperature. The etch structures of the coatings change dramatically in certain cases as the etching time is increased. But the dependence on etching time varies for particles having different preparation histories and thus complicates the use of this technique to characterize PyC coatings on HTGR fuel particles. The etch structure is also affected by the distribution of pores in the coatings. High etching rates occurred in localized areas of the coatings where the original pore concentration was high.

2772 (ORNL/TM—5502) **Irradiation performance of HTGR recycle fissile fuel.** Homan, F.J.; Long, E.L. Jr. (Oak Ridge National Lab., Tenn. (USA)). Aug 1976. Contract W-7405-eng-26. 47p. Dep. NTIS $4.50.

The irradiation performance of candidate HTGR recycle fissile fuel under accelerated testing conditions is reviewed. Failure modes for coated-particle fuels are described, and the performance of candidate recycle fissile fuels is discussed in terms of these failure modes. The bases on which UO_2 and $(Th,U)O_2$ were rejected as candidate recycle fissile fuels are outlined, along with the bases on which the weak-acid resin (WAR)-derived fissile fuel was selected as the reference recycle kernel. Comparisons are made relative to the irradiation behavior of WAR-derived fuels of varying stoichiometry and conclusions are drawn about the optimum stoichiometry and the range of acceptable values. Plans for future testing in support of specification development, confirmation of the results of accelerated testing by real-time experiments, and improvement in fuel performance and reliability are described.

2773 (RD/B/N—3482) **The in-situ measurement of thread strain in mild steel bolts.** Haines, N.F.; McIntyre, P.J. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). Sep 1975. 19p. INIS.

A technique has been developed for making remote measurements of thread strain in mild steel bolts. Experience gained with an instrument designed to make measurements on 3/4in BSF bolts in a Magnox reactor has demonstrated that an extension of 0.03mm may be observed on an individual thread. However, the minimum observable mean strain over N threads is reduced to $0.03/\sqrt{N}$mm. Although the instrument developed was designed for a particular application the overall size and weight could be considerably reduced, particularly for a hand operated device. The present instrument has a diameter of 120mm, a height of 150mm and weight 4.7Kg. It is considered that measurements can be made on conventional bolts (excluding socket head) of diameter greater than 1/2in.

2774 **Nuclear engineering: plant and components.** Tanner, F. *BBC-Nachr.*; **57**: No. 10, 526-531(1975). (In German).

8 figs.; 2 tabs.

In many areas of nuclear engineering, BBC has gained comprehensive knowledge and experience which are available to the customers interested in nuclear power stations. The article describes problems and solutions in the field of control rods, coolant gas circulators and other plant components; in addition, some of the manufacturing facilities required for nuclear components are discussed.

2775 **Development of helium turbines for high-temperature reactors.** Dibelius, G. pp 45-64 of In Energy technology with regard to future developments. Honnens, M.; Zobel, M. (comps.). Frankfurt am Main, F.R. Germany; Verlags- und Wirtschaftsgesellschaft der Elektrizitaetswerke m.b.H. (1975). (In German)

17 figs.

The shortcomings and advantages of various HTR concepts with helium or steam turbines are discussed. Efficiencies, pressures, the costs of electric power generation and problems of heat removal all play an important part in this comparison. The problems of development still to be solved are illustrated by the example of the test plants of the helium gas turbine Oberhausen II and the HHV plant.

2776 Power plants with high-temperature reactor and helium turbine. Weiskopf, H. *BBC-Nachr.*; **57**: No. 11, 616-617(1975). (In German).

3 figs. Short communication only.

2777 (ORNL-tr—4177) **Cesium diffusion in fuel element graphite A3.** Hensel, W.; Hoinkis, E.; Stritzke, D. (Hahn-Meitner-Institut fuer Kernforschung Berlin G.m.b.H. (Germany, F.R.). Bereich Kernchemie und Reaktor). 1975. Translated by M. Gerrard from German. 4p. Dep. NTIS $3.50.

For calculating the ^{137}Cs release rate in the helium loop of a gas-cooled high-temperature reactor, we need to know the value of the diffusion coefficient in the coating of the fuel element (BE) at temperatures between 800 and 1200°C. In the past diffusion coefficients have been determined chiefly on unirradiated material as concentration profiles, which are produced by the "sandwich" technique. The cesium activity in the cooling gas is mainly by fission of uranium which during the high-temperature processing reaches the graphite matrix by diffusion from the fuel particles. The cesium transport velocity in the fuel-free BE coating is possibly affected by changes in the properties of the graphite as a result of the reactor irradiation. Measurements were made of the time and temperature dependence of the cesium release rate from the coating of the irradiated BE and from the cesium-loaded unirradiated BE graphite samples.

2778 Nuclear reactor with a fill of spherical fuel elements and method of reactor operation. Maly, V.; Teuchert, E. (to Kernforschungsanlage Juelich G.m.b.H.). German(FRG) Patent 2,347,817/A/. 24 Apr 1975. 17p. (In German).

2 figs.

In this type of pebble-bed reactor, early damage to the top reflector and parts of the graphite side reflectors is prevented. In one-region reactors, e.g. coated particles with a diameter of 100 μm and a filling of boron, hafnium, or other neutron-absorbing materials are put into these parts which are exposed to fast neutrons. A total cross section of 0.0016 cm^{-1} can thus be achieved. In two-region reactors, special fills of spheres are used instead in a layer with a thickness of 20-40 cm adjacent to the side reflector. Some of these spheres contain a Pu isotope mixture with a large fraction of Pu-240 or Th-232 with a fraction of 20-30 g per sphere as neutron absorbing materials.

2779 Nuclear fuel particle for the fabrication of nuclear fuel bodies. Hosegood, S.B. (to Commission of the European Communities, Luxembourg). German(FRG) Patent 2501869/A/. 31 Jul 1975. 13p. (In German).

1 fig.

Nuclear fuel particles are introduced into the HTR thorium cycle and contain a core of fissile material such as, e.g., U-235, bred U-233 or Pu 239, and laminated breeder material around it, e.g. Th 232 or U-238. For a better separation of both materials after irradiation, both parts of a barrier of pyrolitic pyrocarbon, silicon carbide or combinations of these are separated from one another. Both materials are coated by means of a mixture of graphite powder and resin binder as well as pressure deformation. In the preparation of the layers of cores made of breeder or fissile material, one starts with the carbide form, and an agglomeration process or a sol-gel process is applied. The barrier between the breeder and fission material as well as a possibly available further external barrier retain the fission products.

2780 Breeder and/or fuel particle for nuclear reactors. Naoumidis, A.; Nickel, H. (to Kernforschungsanlage Juelich G.m.b.H.). German(FRG) Patent 2,341,063/C/. 2 Oct 1975. 3p. (In German).

The thermal stability of the spherical fuel and/or breeder particles of the HTR is guaranteed and the amoeba effect prevented. Nitrogen is added in dissolved form as homogeneous mixed phase or as mixed crystal forming compound to the carbide of the core coated with pyrolytic carbon with or without silicon carbide. The nitrogen in the UC_2 phase is dissolved with a share of 100 to 10,000 ppm in the application of uranium carbide. If very high temperatures occur, it is then advantageous to make the core of fuel and/or breeder carbide crystals mixed with fuel and/or breeder nitride crystals. (U,Zr)(C,N) mixed crystals for example are suitable as a core. The sintering temperatures for manufacturing the core are 2,000°C with homogeneous mixed phase and between 1,600° and 1,900°C with mixed crystals under a pressure of 7 to 700 mm.Hg. A mixture of oxides of the metals uranium and zirconium with a mixture ratio between 5:1 and 1:5 forms the initial mixture for the (U,Zr)(C,N) mixed crystals.

2781 Nuclear reactor pressure vessels. Brissaud, J.; Birch, W. (to Technigaz). British Patent 1,411,375/B/. 22 Oct 1975. 6p.

Reference is made to gas cooled reactors having prestressed concrete pressure vessels. Such pressure vessels entail the use of high grade thermal insulation, capable of satisfactory use in high pressure gas environments, in order to combat the sensitivity of concrete to high temperature. Temperature limitations both in regard to absolute temperature and allowable gradients through the vessel walls require the use of a protective thermal barrier on the inside of the pressure vessel wall to separate the gas coolant from the concrete. This barrier must also be designed to withstand, or be isolated from, the intense noise arising from the gas circulators. In the arrangement described the thermal barrier system comprises a metal liner to which is fixed an impervious inner metal membrane having flexible corrugated thinner metal portions.

2782 Ventilation system and iodine separation in the controlled area of a high temperature reactor. Pecornik, D.; Gabriel, W. (Brown, Boveri und Cie A.G., Mannheim (F.R. Germany); Hochtemperatur-Reaktorbau G.m.b.H., Mannheim (F.R. Germany)). *Kerntechnik;* **17**: No. 11, 482-485(Nov 1975). (In German, English).

5 figs.; 6 refs.

Rooms in the controlled area of a high temperature gas cooled reactor may be contaminated by the radioactivity of various air borne fission products, particularly by the characteristic iodine compounds. This report describes the individual ventilation plants and their mutual influences. The filter plants are presented and the use of a new nonflammable filter material AC-6,120 is recommended for the adsorption of radioactive iodine.

2783 In-pile times of side reflectors of pebble bed reactors with high gas outlet temperature. Schulten, R.; Novy, D.; Petersen, K. (Kernforschungsanlage Juelich G.m.b.H. (F.R. Germany). Inst. fuer Reaktorentwicklung). *Atomwirtsch., Atomtech.;* **20**: No. 11, 569-571(Nov 1975). (In German).

4 figs.; 5 refs. Short communication only.

2784 Some aspects of the HTR fuel cycle and the possibilities of utilizing nuclear HTR heat. Feigenspan, B. (Zentralinstitut fuer Kernforschung, Rossendorf bei Dresden (German Democratic Republic)). *Kernenergie;* **19**: No. 3, 69-73(1976). (In German).

A condensed review is given of specific HTR fuel cycle problems including thorium fuel. Coated particle structure, different fuel element concepts and methods of refuelling are discussed. Further, some possibilities of applying HTR heat are described.

2785 Hartlepool power station: major civil engineering features. Coates, F.W. (Central Electricity Generating Board, Cheltenham (UK)); Taylor, R.S. *Proc. Inst. Civ. Eng. (London);* **60**: 95-121(Feb 1976).

The design and construction of some of the major engineering features of the advanced gas reactor nuclear power station at Hartlepool, including the 'integrated' building concept and the construction methods adopted are described. Details are included of the novel techniques adopted to support the heavy reactor vessels on the Bunter sandstone bedrock some 140 ft below ground level, together with a description of the design and construction of the wire-wound pod boiler pressure vessels. The circulating water system for the station is also described.

2786 Application of Bondarenko formalism to HTGR multigroup cross-section generation. Stamatelatos, M.G. (Los Alamos Scientific Lab., NM); LaBauve, R.J.; Becker, M.J. *Trans. Am. Nucl. Soc.;* **23**: 529-530(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

POWER REACTORS, NON-BREEDING, OTHERWISE MODERATED OR UNMODERATED

REFER ALSO TO CITATION(S) 3224, 3228

2787 (AECL—1913) **Impurity effects in the fouling of heat transfer surfaces by organic coolants.** Bancroft, A.R.; Charlesworth, D.H.; Duerksen, J.H. (Atomic Energy of Canada Ltd., Chalk River, Ontario). May 1965. 59p. (CRCE—1189). Dep. NTIS (US Sales Only) $4.50. AECL $1.50.

Previous work had shown that fouling in organic-cooled systems resulted from impurities in the terphenyl-based coolant. Tests in small loops of the effect on fouling of various impurities are reported here which give further insight into the fouling mechanisms and show that chlorine is by far the strongest promoter of fouling. Small effects of radiolysis products, water and oxygen were observed. In a 1000-hr out-reactor test the rate of increase in thermal resistance at the heater surface was related to

deposition rate. On the basis of this test a deposition rate of 0.2 μg/cm²-hr will cause an increase of 25°C/year in the sheath temperature of fuel elements having a heat flux of 100 W/cm². In-reactor loop tests demonstrated that by continuous coolant purification and exclusion of impurities such as chlorine fouling under power reactor conditions can be restricted to acceptable rates.

2788 (AECL—5227, pp 19-21) **Decontamination.** Montford, B. Aug 1975.

In Materials research in AECL. Summer 1975.

Development of special techniques has permitted the use of mild decontamination processes for the CANDU type reactor primary coolant circuit, overcoming many of the problems associated with conventional decontamination processes, which use strong, acidic reagents.

2789 (AECL—5227, pp 15-18) **Development and evaluation of hot filters.** Thexton, H.E. (Atomic Energy of Canada Ltd., Pinawa, Manitoba. Whiteshell Nuclear Research Establishment). Aug 1975.

In Materials research in AECL. Summer 1975.

High temperature, high flow filtration removes radioactive particles from the primary coolant, as well as inactive particles before they can become activated. Canadian experience with edge, graphite, and magnetic filters is described.

2790 (PNC-N—341-75-10) **Heavy-water critical experiment for FUGEN, (3). Control rod effects.** Matsumoto, M.; Haga, T.; Ueda, M. (Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). Jun 1975. 27p. (CONF-750608—15). INIS.

From Annual meeting of the institute of nuclear materials management; New Orleans, Louisiana, USA (18 Jun 1975).

The control rod experiment has been done in the Deuterium Critical Assembly (DCA) by using annular absorbers which simulate control rods of the FUGEN reactor, a prototype heavy-water moderated, boiling-light-water cooled, and pressure tube type reactor. The DCA cores for this experiment use 1.2% enriched UO_2 fuel, and consist of 28-pin fuel clusters arranged in a square array of 22.5 cm lattice pitch. The experiment has been carried out with various control rod geometries, and also with varying coolant void fraction. Experimental results have been analyzed by the "Absorption Area Method", which was employed in the calculation of the FUGEN control rod design. The calculated reactivity worth agreed with the experiment within +-10%. The calculation tended to somewhat over-estimate the reactivity worth for the non-voided core, and under-estimate for the voided core. This tendency was greatly improved by considering the anisotropy effect of migration area M^2 of the cluster lattice.

2791 **System of recurring inspection in the first Czechoslovak nuclear power plant.** Brumovsky, M.; Stepanek, S. (Skoda, Plzen (Czechoslovakia)); Havel, S.; Planek, V.; Filip, R. pp 52-58 of In Periodic inspection of pressurized components. A conference arranged by the Applied Mechanics Group and the Nuclear Energy Group of the Institution of Mechanical Engineers, London, 4-6 June 1974. London; Mechanical Engineering Pub. for Institution of Mechanical Engineers (1975).

From Conference on periodic inspection of pressurized components; London, UK (4 Jun 1974).

The work carried out to ensure the safety of the pressure vessels of the Czechoslovak heavy water reactor A1 is described. Methods of access were evaluated and existing defects analysed. Certain welded joints were then selected for periodic inspection by ultrasonic testing, the schemes for which are described. A program of surveillance samples which is directed to the study of changes in selected mechanical properties of pressure vessel material is also described. The first part consists of tests of specific radiation resistance carried out during the first year of operation in an experimental reactor to determine the difference between individual melts and welded joints used in the construction of the cylindrical shell of the pressure vessel. In the second part of the program samples are inserted directly into the reactor in order to study changes in mechanical properties during long term operation. The importance of brittle fracture and the role of fracture analysis in determining safety of the vessel is discussed.

2792 **The development of periodic inspection requirements for CANDU-type reactors.** Thomas, R.A. (Atomic Energy Control Board, Ottawa, Ontario (Canada)); Legg, G.G. pp 129-138 of In Periodic inspection of pressurized components. A conference arranged by the Applied Mechanics Group and the Nuclear Energy Group of the Institution of Mechanical Engineers, London, 4-6 June 1974. London; Mechanical Engineering Pub. for Institution of Mechanical Engineers (1975).

From Conference on periodic inspection of pressurized components; London, UK (4 Jun 1974).

Work is progressing in Canada to develop a guide better suited to the inspection of CANDU-reactor systems than ASME Code Section XI an 'In-service Inspection of Nuclear Reactor Coolant Systems'. This was intended for light water reactor systems where the major component is a thick-walled reactor pressure vessel and it is therefore not fully appropriate to heavy water CANDU-reactor systems which are comprised mainly of thin-walled pipe-like components. The background to the Canadian effort is reviewed and at the same time the principles on which the approach is being based are discussed.

2793 **In-service inspection of the Winfrith SGHW reactor primary coolant circuit.** Turner, F.; Jackson, H. (UKAEA Reactor Group, Risley). pp 78-87 of In Periodic inspection of pressurized components. A conference arranged by the Applied Mechanics Group and the Nuclear Energy Group of the Institution of Mechanical Engineers, London, 4-6 June 1974. London; Mechanical Engineering Pub. for Institution of Mechanical Engineers (1975).

From Conference on periodic inspection of pressurized components; London, UK (4 Jun 1974).

The SGHWR has been operating since December 1967, during which time increasing amounts of in-service NDT inspection have been carried out, e.g. on steam drums, emergency cooling water vessel and pressure tubes. Inspection of the primary coolant circuit pipework and other components has, however, been confined to visual and dye penetrant inspection. Therefore, in late 1972 it was decided to carry out a full NDT volumetric inspection of this circuit. The planning of the inspection, development of ultrasonic techniques and the actual inspection are described.

2794 **Advance in manufacture of power equipment in the years 1945 to 1975.** Drahy, J. (Skoda, Plzen (Czechoslovakia). Zavod Turbiny); Masek, K. (Skoda, Plzen (Czechoslovakia). Zavod Doudlevce); Patrovsky, V. (Skoda, Plzen (Czechoslovakia). Zavod Vystavba Jadernych Elektraren). *Tech. Skoda;* **5**: No. 1-2, 5-26(Sep 1975). (In Czech).

A survey is presented of experience with the construction and start-up of the A-1 nuclear power plant in Jaslovske Bohunice (Czechoslovakia) and significance of the plant for nuclear power in the country is indicated. The main reactor components and the fuel element are briefly described and the principal operating parameters of the plant are listed. An outline is also given of development efforts on conventional power turbines and turboalternators at SKODA Works, Plzen, in the years 1945 to 1975.

2795 **Steam generating heavy water reactor. Pt.2. The SGHWR commercial design.** Middleton, J.E. (Institution of Nuclear Engineers, London (UK)). *J. Inst. Nucl. Eng.;* **16**: No. 6, 163-171(Nov 1975).

A review is presented on the evolution of the SGHWR concept by the United Kingdom Atomic Energy Authority and the production of early commercial designs, together with later development by the Design and Construction Companies. This is followed by a description of the current commercial design. Possible future developments are suggested. The many advantageous features of the concept are mentioned with a view to supporting optimism for the future of the system. Headings include the following: safety criteria and risk assessment; emergency core cooling system design and development; protective systems; reactor coolant system; reactivity control; off-load refuelling; pressure containment; 'fence' header coolant circuit design; feed water injection; continuous spray cooling; low pressure cooling systems for residual heat removal during refuelling; high pressure cooling system for guaranteed feed water supply; auxiliary systems; structural materials; calandria and neutron shields; fuel element development; alternative loop circuit design; future developments (use of hydraulic diodes to provide a substantial reverse flow resistance by the generation of a vortex; multi-drum and multi-pump schemes; refuelling alternatives; coolant circuit inversion; use of superheat channels).

2796 **Fueling of D_2O reactors. Pt. 1.** Moldaschl, H.; Dusch, F. (Kraftwerk Union A.G., Erlangen (F.R. Germany)). *Atomkernenergie;* **27**: No. 1, 39-40(1976). (In German).

5 figs.; 5 refs.

The pre-optimization of fuelling natural uranium cores is demonstrated in the case of the D_2O reactor at Atucha (Argentina). As results general directions for natural uranium fuel element shuffling are given. The procedure was performed heuristically by use of the heterogeneous 3-D code TRISIC.

2797 **Heavy-water reactor design.** Morison, W.G. (Ontario Hydro, Toronto). *Trans. Am. Nucl. Soc.;* **23**: 417(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2798 Performance review of CANDU—PHW nuclear-electric units and the Bruce Heavy-Water Plant. Woodhead, L.W. (Ontario Hydro, Toronto). *Trans. Am. Nucl. Soc.*; **23**: 418-419(Jun 1976).
From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2799 Review of the design and manufacture of CANDU fuel. Debnam, H.R. (Westinghouse Electric Corp., Hamilton, Ont.). *Trans. Am. Nucl. Soc.*; **23**: 419-420(Jun 1976).
From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2800 Heavy-water supply. Dahlinger, A. (Atomic Energy of Canada Ltd., Mississauga, Ont.). *Trans. Am. Nucl. Soc.*; **23**: 420(Jun 1976).
From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2801 UK steam-generating heavy-water reactor civil program. Brown, J. (Central Electricity Generating Board, Barnwood, Eng.). *Trans. Am. Nucl. Soc.*; **23**: 420(Jun 1976).
From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2802 SOPHT: a computer model for CANDU-PHWR heat transport networks and their control systems. Chang, Y.F.; Skears, J. (Ontario Hydro, Toronto). *Trans. Am. Nucl. Soc.*; **23**: 489-490(Jun 1976).
From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2803 Nuclear design and its development for FUGEN. Kato, H.; Miyawaki, Y. (Power Reactor and Nuclear Fuel Development Corp., Tokyo). *Trans. Am. Nucl. Soc.*; **23**: 513(Jun 1976).
From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2804 Physics of CANDU reactor design. Roshd, M.H.M. (Atomic Energy of Canada Ltd., Mississauga, Ont.). *Trans. Am. Nucl. Soc.*; **23**: 513-514(Jun 1976).
From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2805 Fuel scheduling experience of Ontario Hydro's CANDU—PHW reactors. Brenciaglia, G.; Brown, R.A.; McCormack, G.R. (Ontario Hydro, Toronto). *Trans. Am. Nucl. Soc.*; **23**: 514-515(Jun 1976).
From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2806 Some physics problems in the design of thorium-fueled CANDU reactors. Milgram, M.S.; Walker, W.H. (Chalk River Nuclear Labs., Ont.). *Trans. Am. Nucl. Soc.*; **23**: 515-516(Jun 1976).
From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2807 Physics calculations for charge design at Savannah River. Sharp, D.A. (E.I. du Pont de Nemours and Co., Aiken, SC). *Trans. Am. Nucl. Soc.*; **23**: 516(Jun 1976).
From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2808 Assessment of the physical simplifications used in nuclear fuel burnup computer codes. El-Meshad, Y. (Alexandria Univ., Egypt); Morsy, S.; El-Osery, I. *Trans. Am. Nucl. Soc.*; **23**: 532-533(Jun 1976).
From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2809 Stationary definition of the doubling time for breeder reactor fuel. Borg, R.C.; Ott, K.O. (Purdue Univ., West Lafayette, IN). *Trans. Am. Nucl. Soc.*; **23**: 533-534(Jun 1976).
From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2810 Optimum burnup distribution in a continuously fueled reactor. Wight, A.L. (Atomic Energy of Canada Ltd., Mississauga, Ont.). *Trans. Am. Nucl. Soc.*; **23**: 543-544(Jun 1976).
From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

POWER REACTORS, BREEDING

REFER ALSO TO CITATION(S) 2743, 3057, 3058, 3059, 3061, 3068, 3125, 3127, 3130, 3136, 3139, 3143, 3145, 3154, 3174, 3175, 3176, 3177, 3178, 3179, 3181, 3182, 3183, 3184, 3185, 3186, 3187, 3188, 3189, 3190, 3191, 3192, 3193, 3194, 3195, 3196, 3197, 3198, 3199, 3201, 3202, 3203, 3204, 3205, 3206, 3207, 3208, 3209, 3210, 3211, 3212, 3213, 3214, 3215, 3216, 3217, 3218, 3219, 3220, 3221, 3222, 3223, 3227, 3250, 3323, 3666

2811 (ANL-CT—74-07) **Dynamic response of a linear elastic/linear strain-hardening thin ring.** Carey, J.J. (Argonne National Lab., Ill. (USA)). Mar 1974. Contract W-31-109-eng-38. 55p. Dep. NTIS $4.50.

In studying the dynamic response of fluid filled cylindrical shells to large internal pressure pulses, it would be advantageous to have a rapid method of computing the final deformed shape of the shell. In treating the dynamic response of liquid metal heat transport system to pressures generated by large sodium/water reactions, determinations of the structural response of various components is only a fraction of the information required to describe the entire event. The problem treated in this report is an initial investigation of the value of correlation parameters for removing the effect of pulse shape on predicted plastic deformation. It is an attempt to extend previous studies by inclusion of elastic/plastic response rather than limiting the model to a rigid/plastic description. Since many of the pressure pulses of interest in piping system analysis do not involve pressures that produce large plastic deformation, it is necessary to include the effect of elastic response. A simple bilinear elastic/strain hardening model was thus chosen for this study. The dynamic response of a bilinear thin ring to various spacially uniform pressure pulses is analyzed. Solutions have been obtained for rectangular and for linear and exponentially decaying pulses. Numerical procedures have been employed to obtain maximum inelastic displacement as a function of material and pulse parameters.

2812 (ANL-CT—76-20) **Irradiation of microphones in the EBR-II core.** Gavin, A.P.; Anderson, T.T.; Bobis, J.P. (Argonne National Lab., Ill. (USA)). Jun 1976. Contract W-31-109-eng-38. 109p. Dep. NTIS $5.50.

Six ANL developed high temperature microphone (acoustic detectors) have been exposed in flowing sodium in the In-Core Instrument Test Facility (INCOT) in the Experimental Breeder Reactor-II (EBR-II) for seven months without any indications of serious degradation of signal output due to the exposure. The YY05 experiment (EBR-II INCOT experiment designation) was performed to obtain data which would be useful in evaluating the ability of the microphones whose active elements are lithium niobate to serve as sensors for acoustic surveillance of fast breeder reactors. The reactor was at full power for 136 days of the experiment exposure period. The microphone temperatures varied from 371°C (700°F) to 621°C (1150°F). Neutron exposure varied from 2.64×10^{22} nvt for the microphone at the elevation of the bottom of the EBR-II core to 0.24×10^{22} nvt for the microphone at the elevation of the top of an EBR-II fuel assembly. The maximum gamma dose was 5×10^{12} rads.

2813 (ANL-CT—76-24) **Design guide for evaluating potential tube vibration in LMFBR steam generators.** Shin, Y.S.; Wambsganss, M.W. (Argonne National Lab., Ill. (USA)). Jun 1976. Contract W-31-109-eng-38. 75p. AT.

Step-by-step calculational procedures are presented for performing an analytical evaluation of potential detrimental flow-induced tube vibration in LMFBR steam generators. Based upon state-of-the-art technology, these procedures include consideration of flow distribution, shell-side crossflow velocities, dimensionless numbers, added mass, tube natural frequencies, vortex shedding, turbulent buffeting, fluidelastic instabilities, and subcritical vibration caused by parallel flow. The configuration and preliminary data for the CRBRP steam generator designed by Atomics International are used to demonstrate the calculational procedures. Technological voids and/or problem areas requiring verification tests are identified along with minimum acceptance criteria applicable to any given steam generator design.

2814 (ANL-CT—76-36) **Study of CRBR outlet plenum thermal oscillations during steady state conditions.** Lorenz, J.J.; Howard, P.A. (Argonne National Lab., Ill. (USA)). Jul 1976. Contract W-31-109-Eng-38. 82p. AT.

An experimental investigation of CRBR outlet plenum thermal oscillations during steady state conditions was conducted. Tests were performed using water with a fully mock-up 1/10-scale model of the CRBR upper plenum complete with Upper Internal Structure (UIS). The radial blanket/fuel assembly temperature difference was adjusted such that Froude number (ratio of buoyant to inertial forces) similitude of model and prototype was obtained. Temperature-time plots were obtained at 47 critical locations within the plenum. Power spectral density (PSD) analysis at particular locations was implemented to examine the frequency range of the thermal oscillations. It was found that significant outlet plenum thermal oscillations (peak to peak oscillation approximately 30 percent of fuel/blanket ΔT) occur only within the UIS mixing chamber in the region above the blanket assemblies. Power spectral density analysis revealed that the oscillations were in the frequency range 0-3 Hz (0-1.2 Hz prototype). Oscillations of this magnitude and frequency range are potentially serious from a design point of view. Outside the UIS, most components (e.g., support columns and vessel liner) were nearly at the mixed mean plenum temperature and oscillations were relatively small (less than 10 percent of the fuel/blanket ΔT). Leakage flow at the clearance gap (between the lower part of the UIS and top of the core) was found to be 7.8 percent (of the total flow) and 12.5 percent (of the total flow) for the 0.254 cm gap (nominal) and 0.508 cm gap, respectively. Doubling the leakage gap had a negligible influence on plenum temperatures; when the gap was eliminated altogether, only temperatures in the immediate neighborhood of the gap were affected.

2815 (CONF-760622—38) **Tritium monitoring system for the GB-10 GCFR fuel irradiation experiment.** Pruitt, M.E. (Oak Ridge National Lab., Tenn. (USA)). 1976. 7p. Dep. NTIS $3.50.

From American Nuclear Society 1976 annual meeting; Toronto, Ontario, Canada (13 Jun 1976).

A tritium monitoring system was designed, tested, installed, and operated on the sweep gas from the GB-10 capsule. The objective was to quantatively determine tritium production, release, cladding permeation, and the molecular species released (HT or HTO). This information is necessary in predicting tritium transport pathways in a GCFR reactor.

2816 (CONF-761001—1) **Quasi-steady state boiling downstream of a central blockage in a 19-rod simulated LMFBR subassembly (FFM bundle 3B).** Hanus, N.; Fontana, M.H.; Gnadt, P.A.; MacPherson, R.E.; Smith, C.M.; Wantland, J.L. (Oak Ridge National Lab., Tenn. (USA)). 1976. Contract W-7405-eng-26. 6p. Dep. NTIS $3.50.

From International meeting on fast reactor safety and related physics; Chicago, Illinois, USA (Oct 1976).

Results of sodium boiling tests in a centrally blocked 19-rod simulated LMFBR subassembly are discussed. The tests were part of the experimental series conducted with bundle 3B in the Fuel Failure Mockup (FFM) at ORNL.

2817 (COO—2245-26) **Coolant mixing in LMFBR rod bundles and outlet plenum mixing transients. Progress report, September 1, 1975—November 30, 1975.** Todreas, N.E.; Golay, M.W. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Nuclear Engineering). 1975. Contract AT(11-1)-2245. 54p. Dep. NTIS $4.50.

Progress is summarized in the following task areas: experimental bundle water mixing investigation, experimental subchannel water mixing investigation, analytic subchannel model development, and analytical and experimental investigation of velocity and temperature fields in outlet plenum flow mixing.

2818 (CRBRP-PMC—76-04) **Clinch River Breeder Reactor Plant Project: chief executive briefing; Proceedings of the Breeder Reactor Corporation, May 1976 information session.** Wilson, K.C. (ed.). (Clinch River Breeder Reactor Plant Project Office, Oak Ridge, Tenn. (USA)). 1976. 43p. (CONF-760535—). AT.

From Proceedings of the Clinch River Breeder Plant Project chief executive information session; Chicago, Illinois, United States of America (USA) (4 May 1976).

The volume presented contains reports on the Clinch River Breeder Reactor Plant Project presented at an information session for Breeder Reactor Corporation chief executives held May 4, 1976, in Chicago, Illinois.

2819 (EURFNR—1323) **Specifications, design, irradiation, and post-irradiation examination of a mixed oxide pin of the Mol-8C-series (pin No. 5).** Ullah, M.Z.; Geithoff, D.; Weimar, P. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Material- und Festkoerperforschung). Nov 1975. 103p. (KFK—2221). AT.

Work performed under United States—Euratom Fast Reactor Exchange Program.

The Mol-8C series is aimed at investigating the influence of various parameters on the irradiation behavior of LMFBR fuel pins. The irradiation was performed in the epithermal flux of the BR-2 reactor in a cadmium shielded and NaK cooled capsule, called FAFNIR. the fuel was $(U, Pu)O_2$ with about 20 percent PuO_2 and 93 percent enriched uranium. The fuel density was 86.6 percent theoretical density and the fuel column length was 522 mm. The cladding material was an austenitic stainless steel (no.1.4988) tube of 6 mm outer diameter and of 0.38 mm wall thickness. The pin length was 1024 mm. The irradiation was completed in 22 cycles in four different channels of the reactor for a total of 427.8 full power days. The clad outside maximum temperature was 575°C. The pin linear power was 393 W/cm and mean burn-up was about 9.6 percent fima. The report presented describes in detail the post-irradiation behavior of one of the pins. Information regarding the specifications, fabrication, and irradiation history of the pin is also given.

2820 (JAPFNR—225) **Preliminary study on the effective use of burnup data for the evaluation of core neutronic performance.** Iida, M.; Aoki, K.; Moriki, Y. (Nippon Atomic Industry Group Co. Ltd., Tokyo). Feb 1976. 141p. (In Japanese). (SJ—201-76-03). Dep. NTIS (US Sales Only) $6.00.

For Power Reactor and Nuclear Fuel Development Corp., Tokyo and Tokyo Shibaura Electric Co. Ltd.

A preliminary study was made on the effective use of JOYO's burnup data for the confirmation of methods adopted in the JOYO design and for application to the design of a large scale LMFBR. Power and burnup distributions, breeding characteristics, effective capture cross sections of heavy nuclides, and Am/Cm build-up are the main subjects treated. A model for evaluating effective capture cross sections was established based on the method of sensitivity analysis and was confirmed by numerical experiments. Requirements on experimental accuracy are also indicated.

2821 (KFK—1275/2, pp vp.) **Fuel rod development.** Fabian, H.; Wedemeyer, H.; Kaiser, H.; Kleykamp, H.; Mueller, I.; Freund, D.; Weimar, P.; Geithoff, D.; Vollath, D.; Sari, C. Oct 1975. (In German).

With figs., tabs. and refs.

In Second quarterly report, 1975.

In the context of mixed oxide fuel fabrication for irradiation tests a report is given of the development of an autoradiographic method for PuO_2 particle size determination. Post-examinations of irradiated fuel rods yieled among other data further details of the chemical and mechanical interactions between the fuel and the cladding. According to in-pile creep tests with carbide and nitride fuels, the creep rate due to irradiation of UN and UC is lower by a factor 7 to 20 than the creep rate for UO_2 while the creep rate of (U, Pu) C is lower by a factor 8 to 15 than for (U, Pu) O_2 under comparable irradiation conditions.

2822 (NEANDC(E)—163-U, pp 19-42) **Importance of resonance parameters of fertile nuclei and of ^{239}Pu isotope for fast power reactors.** Barre, J.Y.; Khairallah, A. Jan 1975.

From Specialists meeting on resonance parameters of fertile nuclei and ^{239}Pu; Saclay, France (20 May 1974).

In Specialists meeting on resonance parameters of fertile nuclei and ^{239}Pu.

The importance of resonance parameters of fertile nuclei and of Pu 239 is discussed for mixed oxide-uranium-plutonium fuelled sodium-cooled and uranium-oxide-sodium reflected fast reactors with power range between 200 and 2000 MWe. Resonance parameters are mainly used in fast power reactor calculations through the well-known concept of self shielding factors. After a short description of the determination and the use of these self-shielding factors, their sensitivities to resonance parameters are characterized from some specific examples: those sensitivities are small. The main design parameters sensitive to the amplitude of self-shielding factors are considered: critical enrichment and global breeding gain. The relative importance of isotope, reaction rate, and energy range are mentionned. The Doppler effect, sensitive to the temperature variation of self-shielding factors, is also considered. It is concluded that the present knowledge of resonance parameters for U 238, Pu 239, and Pu 240 is sufficient for fast power reactors from a design point of view.

2823 (NEDM—14082) **Update of the preliminary reliability prediction for CRBRP shutdown heat removal system.** (General Electric Co., Sunnyvale, Calif. (USA). Fast Breeder Reactor Dept.). Jan 1976. Contract E(04-3)-893. 270p. AT.

The purpose of the report presented is to examine the current prediction of the probability of failure of the CRBRP Shut-

down Heat Removal System (SHRS) to adequately remove reactor heat following shutdown. This analysis is part of the overall CRBRP reliability effort which has the objective of assuring and confirming that the CRBRP has less than one chance in one million per year of exceeding 10 CFR 100 guidelines. As a result of this analysis, it is concluded that the shutdown heat removal unreliability for the baseline design is 1.1×10^{-7} per reactor year. This meets the allocated unreliability of 8×10^{-7} per reactor year for the SHRS. Based on this low value of unreliability and the assurance provided by the material presented, it is recommended that a core disruptive accident as it results from a failure in the SHRS not be included as a CRBRP design basis event.

2824 (RD/B/N—3252) **Design and operation of a small (benchtop) pumped sodium loop.** Trevillion, E.A.; Rowe, D.M.J. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). Aug 1975. 20p. INIS.

The report outlines the design and operation of a small (benchtop) pumped sodium loop (sodium, 650g). The loop incorporates a diffusion cold trap to control the oxygen impurity level in the sodium and a sodium sampler/distillation unit to enable sodium samples to be analysed for impurities. Sodium flow rates of up to $5.5 cm.s^{-1} (1 cm^3.s^{-1})$ have been achieved at temperatures up to 673.2K (400°C) and temperatures of up to 1023.2K (750°C) have been achieved under static conditions. A device for the addition and removal of metallic speciments to and from the loop sodium without contamination of either the specimens or the sodium is also described.

2825 (RD/B/N—3352) **The attenuation of temperature oscillations in passing through liquid metal boundary layers.** Lawn, C.J. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). Aug 1975. 42p. INIS.

One aspect of predicting the endurance of components subject to thermal fatigue in liquid metal cooled reactors is the extent to which oscillations in fluid temperature are transmitted to metal surfaces, such as the above-core structure. The first geometry considered is that of a solid plate in contact with a layer of stagnant fluid, in which temperature oscillations are imposed at a given distance from the plate. Transmission through a laminar boundary layer developing over the plate surface is then considered. An approximate calculation based on the slug-flow analysis of Sucec (1975) is developed.

2826 (RED—76-93) **Report to the Joint Economic Committee Congress of the United States by the Comptroller General of the United States. Can the U.S. breeder reactor development program be accelerated by using foreign technology.** (General Accounting Office, Washington, D.C. (USA)). 6 May 1976. 152p. General Accounting Office, Washington, DC.

For years the United States, Britain, France, the Federal Republic of Germany, the Soviet Union, and Japan have been conducting extensive fast breeder reactor research and development programs. Except for the Soviet Union, these countries lack the energy resources—coal, oil, natural gas, and uranium—that the U.S. possesses and have more urgent needs and shorter time frames for developing commercial fast breeder reactors than does the U.S. This report deals with the status of the foreign LMFBR programs and the benefits from and impediments to exchanging foreign LMFBR technology. It is concluded that although the Energy Research and Development Administration's efforts to develop areas of exchange are worthwhile and should be continued, it is unrealistic to expect that the U.S. program could be greatly accelerated or that large amounts of money could be saved through quid pro quo exchanges with other nations.

2827 (TRG-REPORT—2690(D)) **A digital real-time reactivity meter for PFR.** McWilliams, D. (UKAEA Reactor Group, Risley). Aug 1975. 45p. INIS.

Available from H.M. Stationery Office, price Pound 1.50.

A digital reactivity meter has been produced which is believed to constitute a significant advance over others reported in the literature. The main advantage of the system is its versatility which is brought about by the high degree of interactive operator control provided. The reactivity and power are continuously displayed in both graphical and alpha-numeric form on a TV-type of display unit. Data output is by means of an incremental graph plotter, a typewriter, or a high speed paper tape punch. The system has been extensively tested on the Prototype Fast Reactor at Dounreay and is now the standard reactivity measuring method for reactor experiments there.

2828 (TRG-REPORT—2733(R)) **NABUB: a non-saturated model of coolant boiling in a fast reactor sub-assembly.** Brook, A.J.; Mills, D.S. (UKAEA Reactor Group, Risley). Aug 1975. 55p. INIS.

Available from H.M. Stationery Office, price Pound 1.50.

A theoretical model is described of sodium boiling in a fast reactor sub-assembly in which the usual assumptions of a saturated vapour are not made. Instead, vapour pressure is calculated in a perfect gas basis, which enables some allowance to be made for the possible presence of non-condensables, which may inhibit the condensation of the vapour. Indications are given of the circumstances under which such inhibition might be expected to show the most marked effects, and some sample results obtained by the code are presented. These show that the coolant voiding pattern is most sensitive to restrictions on the condensing flux in the 100 to $200 w/cm^2$ range. If unrestricted condensation is assumed, the results of the code are in excellent agreement with more conventional saturation models.

2829 (WARD-SG—3045-3) **Alternate steam generator development program. Fluidized bed steam generator development.** Mangus, J.D. (Westinghouse Electric Corp., Madison, Pa. (USA). Advanced Reactors Div.). Mar 1976. Contract E(11-1)-3045-TAS-30-CW080. 162p. AT.

A fluidized bed steam generation system is being developed for the Liquid Metal Fast Breeder Reactor (LMFBR). The fluidized bed steam generator eliminates the need for an intermediate sodium loop and heat exchanger as utilized in the current design and isolates the sodium and water, thus reducing the possibility of a sodium-water reaction. Experimental test programs have been carried out to investigate the performance and to develop design criteria for the reference design. Experimental tests on sodium, steam and water leaks; metal powder agglomeration; steam tube leak jet impingement; particle attrition; and steam/water tube erosion were carried out. The results provide initial design and operating criteria for commercial plant designs. No problems which preclude commercial development were identified from the tests. However, due to the early termination of the work, further experimental tests, data evaluation, and design work are required and recommended to develop an economic fluidized bed steam generator for the LMFBR.

2830 (WARD-SG—3045-4) **Alternate steam generator development program. Final report, September 1974—January 1976. Volume 5.** Mangus, J.D. (Westinghouse Electric Corp., Madison, Pa. (USA). Advanced Reactors Div.). Feb 1976. Contract E(11-1)-3045-TAS-30-CW080. 154p. AT.

The final summary of the Westinghouse effort on primary steam generators during the period September 1974 to January 1976 is presented. It was concluded in the study that both the stacked tube-bundle fluid bed and the solid-conductor steam generators are technically feasible, are capable of being reliably manufactured using conventional methods, and are economically competitive with one another. Specific conclusions regarding each steam generator type are presented.

2831 **A device for heat-proofing the closing slab of a fast neutron nuclear reactor.** Lemercier, Guy. (to CEA, 75 - Paris (France)). French Patent 2,241,849/A/. 26 Jun 1973. 13p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France).

A device for heat-proofing the closing-slab is described which comprises a metal-shoe against which is applied the device, the latter being constituted by a plurality of panels, each of which is formed by a padding of superimposed metal-cloths arranged in parallel relationship to the slab to be heat-proofed. The device is characterized in that each panel is contained in a casing applied against the slab, constituted by two metal half-boxes of parallelepipedic shape embedded into each other. This can be applied to high-power reactors for protecting the slab against the aerosols of the coolant liquid-metal.

2832 **A device for connecting two tubular conduits mounted end-to-end.** Bentz, Alfred; Depierre, Yves; Venobre, Henri. (to CEA, 75 - Paris (France)). French Patent 2,242,631/A/. 31 Aug 1973. 12p. (In French).

Available from Institut National de la Propriete Industrielle Paris (France).

The device is characterized in that it comprises means for the centering and mutual backing of the ends of the two conduits, and low-leakage sealing means independent of the centering means. The device can be applied to the connection of a primary-pump outlet conduit with piping for returning the cooling-sodium under the core in a fast neutron nuclear reactor.

2833 **A method and device for the passive protection of a nuclear reactor.** Cachera, P.C. (to Electricite de France, 75 - Paris). French Patent 2,242,747/E/. 31 Aug 1973. 7p. (In French).

Addition to the French patent document 7245541; available from Institut National de la Propriete Industrielle, Paris (France).

Descriptions are given of an improvement in a device for the passive protection of a nuclear reactor, the improvement relating to the reactor fuel elements called safety elements. Each of the safety elements is provided, in the lower portion thereof, with a part mating with the reactor-core lower-cover, the part being of refractory material and being provided, along a portion of its height and in the upper portion thereof, with an axial channel of substantially the same diameter as the channel in the fuel-element fissile portion. This can be applied to liquid-sodium-cooled fast neutron reactors.

2834 Fuel rods for gas-cooled nuclear reactors. (to UKAEA). French Patent 2,242,748/A/. 3 Sep 1973. 19p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France).

The present invention relates to fuel rods for gas cooled nuclear reactors. A fuel rod comprises an open ended tubular clad, a bundle of spaced tubes, the axes of which are in parallel relationship and parallel to the clad-axis, the structural elements combining the tube bundle with the clad so as to form a unitary assembly, defining a first plurality of channels constituted by the tube bores and a second plurality of channels constituted by the spaces between the tube external surfaces and the clad, and a mass of porous nuclear fuel, pervious to the coolant and contained in the channels of the above first or second categories. This can be applied to nuclear reactors in particular to fast neutron reactors.

2835 A method for the continuous control of the tightness and working order of the second vessel of a reactor using said method. Cachera, P.C. (to Electricite de France, 75 - Paris). French Patent 2243499/A/. 7 Sep 1973. 8p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France).

The invention described relates to a method for controlling a sodium cooled fast-neutron reactor of the type comprising a first enclosure or main vessel containing the core and sodium above which is a cover of an inert gas, and a second enclosure, or second vessel surrounding the first one, both enclosures being contained in a safety enclosure closed at the upper part thereof, by a slab. The reactor comprises means for feeding the space defined by the first two enclosures with an inert gas, and for maintaining the pressure therein in the vicinity of atmosphere pressure, means for maintaining a vacuum between the second enclosure and the safety enclosure and means for sensing the presence of gas between said enclosures further to a possible leak in said second enclosure. This can be applied to high-power fast-neutron reactors.

2836 Fast neutron nuclear reactor. Iljunin, V.G.; Murogov, V.M.; Shmelev, A.N. French Patent 2243494/A/. 11 Sep 1973. 26p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France).

The invention described relates to fast neutron nuclear reactors. In such reactors, the active zone and the lateral and front fertile zones around the latter are constituted by fuel element bundles. Ports are provided in the walls of each of said bundles, halfway up the active zone. Both above and under the plane passing through the centers of said ports, main fuel elements and extra fuel elements are arranged in said bundles. The space between these elements, together with the ports, forms the inlet manifold for the coolant which will contact said element. Said inlet manifold divides the coolant into two streams of opposite directions flowing through two outlet manifolds under and above the upper and lower front fertile zones.

2837 An installation for purifying the liquid metal used for cooling the core of a fast neutron nuclear reactor. Abramson, R.; Delisle, J.P.; Elie, X. (to CEA, 75 - Paris (France)). French Patent 2246942/A/. 3 Oct 1973. 12p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France).

An installation for purifying the liquid metal used for cooling the core of a fast neutron nuclear reactor is described. That installation, comprising at least one cold trap through which the liquid metal flows is characterized in that trap is fully immersed in the reactor vessel, said cold trap being preferably constituted by an assembly which can be removed through an orifice provided in the reactor cover plate. Such an arrangement makes it possible to replace the cold trap easily without modifying the arrangement of the other parts.

2838 A mutual induction level probe with automatic temperature compensation. Paris, M.; Poinsot, S. (to CEA, 75 - Paris (France)). French Patent 2246850/A/. 5 Oct 1973. 12p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France).

The invention described relates to a level probe with mutual induction means and automatic temperature compensation means. The probe for measuring levels is characterized in that it comprises two intertwined insulated cables, wound about a rigid supporting means, the first cable being the primary and the second cable the secondary, a resistor mounted at the second cable terminals for cancelling variations, according to the temperature, of the voltage at the secondary outlet. This can be applied to the measurement of the level of liquid sodium in nuclear reactor vessels.

2839 A device for supporting the core of a fast neutron reactor. Lleres, J.; Perona, M. (Alsthom, 38 - Grenoble (France). Div. Neyrpic); Venot, R. (Groupement pour les Activites Atomiques et Avancees (GAAA), 92 - Le Plessis-Robinson (France)); Martin, J.P. (Societe Technique pour l'Energie Atomique (Technicatome), Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)). (to CEA, 75 - Paris (France)). French Patent 2246941/A/. 9 Oct 1973. 10p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France).

The invention described relates to a core-supporting device. It is characterized in that the flooring is constituted by a rigid annular structure provided with a plane annular flange, in that the grid comprises a plane annular bearing flange, the grid annular flange resting on the flooring annular flange, and in that the tubes opening into said grid for feeding the latter with cooling liquid sodium are expanding bellows. This can be applied to the fixation of the core in fast neutron reactors.

2840 A method for detecting the rupture of a fuel element in a fast neutron breeder reactor. Cohen, P. (to USAEC). French Patent 2,238,995/A/. 18 Jul 1974. 12p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France); priority claim: 23 Jul 1973, USA.

The method according to the invention is characterized by the steps of balancing a cooling sodium sample driven through a nozzle into a molten salt constituted by a baryum-iodide strontium-iodide mixture, so that a substantial portion of radioactive iodine contingently present in the liquid sodium accumulates in the molten salt through isotopic exchange, separating the molten salt from sodium, balancing (if required) the molten salt with nonradioactive sodium and separating the molten salt from the sodium, and controlling the molten salt in order to determine the presence of iodine, such presence being-indicative of the rupture (or burst) of a fuel element sheath. Such a method is suitable in particular for detecting the rupture of a fuel element in a sodium-cooled fast breeder-reactor.

2841 Device and method for the exhaust of gases from the control rods and fuel elements of nuclear reactors. Christensen, J.A. (to USAEC, Washington, D.C.). French Patent 2244234/A/. 13 Sep 1974. 11p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France); priority claim: 13 Sep 1973, USA.

The exhaust device according to the invention is characterized by a plug sealingly mounted in a hole of the control rod cladding or of the fuel rod, said plug being made of a silver-copper-zinc-tin alloy or of a silver-nickel alloy in two continuous phases, in order that said plug be gas-tight before being in contact with high-temperature sodium and that said high-temperature sodium dissolve one of said phases, thus leaving a gas-pervious but sodium-impervious porous matrix. Such a device is suitable in particular for the control rods and fuel elements of sodium-cooled fast-neutron breeders.

2842 Flexible connector for tubes. Whitby, C.R.; Richardson, J. (to UKAEA). French Patent 2244957/A/. 20 Sep 1974. 10p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France); priority claim: 21 Sep 1973, UK.

The invention described relates to a flexible connecting unit adapted to connect two tubes. Said unit comprises a tension brace and an extensible sealing sleeve. The cylindrical brace comprises three sets of parallel tie rods embedded in two annular end pieces. The sleeve comprises tubular end pieces applied against the ends of the tubes and carrying abutments for receiving the brace end pieces. An adjusting device sets the brace in tension and permits introduction of the latter into a conduit while its axis is inclined with respect to the axis of at least one of said sleeve end pieces. The invention applies to the connection of tubes for circulating fluids such as nuclear reactor coolants.

2843 (BNWL-tr—181) **Reports on the fast reactors: Rapsodie, Phenix, Creys Malville, and Super Phenix.** 1975. Translated by L. Appleby from French. (CONF-751030—4). 60p. Dep. NTIS $4.50.

From International nuclear industries fair; Basel, Switzerland (7 Oct 1975).

The fast reactor Rapsodie has operated for 8 years. Despite the demands imposed on the operation by the execution of a very important experimental program, the availability is near 60 percent, and in some years approached 75 percent. The reactor of the Phenix Station reached criticality for the first time on August 31, 1973. The test period ended July 14, 1974. Since that date, the Station has been in normal operation and its availability is above 80 percent.

2844 (ANL-Trans—1074) **Power plant of Creys-Malville options and descriptions.** Saitcevsky, B.; Robert, E.; Casini, R.; Janberg, K.; Megy, J.; Crette, J.P.; Granito, F.; Leduc, J. (Societe Centrale Nucleaire Europeenne a Neutrons Rapides (NERSA), 69 - Lyon (France); CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)). 1975. Translated by J. Banfield from French. (CONF-750411—94). 37p. Dep. NTIS $4.00.

From European nuclear conference; Paris, France (21 Apr 1975).

The power plant of CREYS-MALVILLE is the third stage of a program which began with the experimental pile RAPSODIE and the demonstration power plant PHENIX. This is a first industrial realization in which the prime contractor will be NERSA and of which the steam plant will be supplied by the SUPER-PHENIX group under license of the Commissariat a l'Energie Atomique (CEA). The power plant of CREYS-MALVILLE will be a base loaded power plant. The essentials of the options which were taken for PHENIX, were preserved (fuel UO_2-PUO_2, integral primary system, core instrumentation, handling mechanisms, etc.). The principal modifications have to do with the number of secondary systems, the primary sodium purification system, and the steam generators etc. A general description of the power and its operation is given.

2845 **A system to reduce the hazards of a reactor core meltdown.** Barleon, L.; Dorner, S.; Goetzmann, O.; Kussmaul, G. (to Gesellschaft fuer Kernforschung m.b.H.). German(FRG) Patent 2,363,845/A/. 26 Jun 1975. 9p. (In German).

4 figs.

The core catcher, e.g. of an SNR, is manufactured or encased with materials preventing melting to lessen the consequences of a core meltdown accident. It or its coating consists of densely pressed graphite which is additionally separated from the coolant with a metallic or boron carbide or boron nitride layer. On the other hand, the coating may also consist of carbides or material combinations of graphite fibers with thread fibers with carbides, borides or silicides. The materials B_4C, Al_4C_3, α-SiC, β-SiC, TiC, BN, TiB_2, ZrB_2, HfB_2, VB_2, NbB_2, WSi_2 and HfB_2-WSi_2-graphite material combinations are particularly suitable.

2846 **Centering for fuel rod clusters.** Feldmann, W.; Godesar, K.R. (to Internationale Atomreaktorbau G.m.b.H. (INTERATOM), Bensberg/Koeln (F.R. Germany); Societe Belge pour l'Industrie Nucleaire, Brussels). German(FRG) Patent 2,364,349/A/. 26 Jun 1975. 9p. (In German).

3 figs.

The centering is devised for spacers in the duct tubes of SNR reactors. They evenly distribute the gap resulting from manufacturing tolerances. Besides, they direct the coolant flow towards the center, so that the outer coolant channels give better cooling to the peripheral fuel rods. The centering consists of arched leaf springs distributed in longitudinal direction across the inner wall of the duct tube. They are inserted in grooves in the spacers and have a convex region which is in contact with the inner wall. Towards their ends they are slightly concave and they are welded to the spacers with four welding points. The spaces between the leaf springs are narrow.

2847 **Nuclear reactor fuel element assemblies.** Linning, D.L.; McAreavey, G. (to UKAEA). British Patent 1402936/B/. 13 Aug 1975. 4p.

Reference is made to fuel element assemblies of the type comprising a bundle of spaced fuel pins enclosed in a casing, referred to as a 'wrapper', through which liquid coolant can flow. Such assemblies may be used in a fast breeder reactor, where they are clustered in close parallel array upstanding from a diagrid. The improved assembly described comprises a bundle of fuel pins, with wire wrap spacing means, enclosed in a 'wrapper' through which liquid coolant can be passed. The 'wrapper' has a flexible lining that in conjunction with the 'wrapper' defines an interspace to contain pressurised gas; the lining is inwardly flexible by pressurised gas to embrace the bundle of fuel pins. In use the lining is pressurised against the bundle of fuel pins, thereby bracing the pins against bowing and vibration. The coolant flow through the bundle remains substantially constant since the lining can expand to accommodate fuel pin swelling. The jacket of gas also provides a thermal barrier to reduce heat transfer from the fuel pins to the 'wrapper' and the 'wrapper' is thus maintained at the relatively lower temperature of the liquid coolant flowing between the fuel element assemblies, which for a sodium cooled fast reactor can be about 400°C. Neutron induced voidage below 400°C is found to be considerably less in some materials suitable for 'wrappers' than at higher temperatures, so that bowing can be considerably reduced. The lining is preferably longitudinally corrugated to promote inward deflection when pressurised.

2848 **Improvements in and relating to gas-cooled breeder reactor installations.** Chermanne, J.-M. (to Societe Belge pour l'Industrie Nucleaire, Brussels). British Patent 1,413,505/B/. 12 Nov 1975. 3p.

A method is described for converting an Advanced Gas Cooled Reactor (AGR) to a gas cooled breeder reactor. The internal parts of the AGR are modified to form the internal parts of a gas cooled breeder reactor and means are provided for expanding the gas from the higher pressure breeder reactor system to the lower pressure of the AGR, and for compressing the gas from the lower pressure AGR to the higher pressure required for the breeder reactor system. This means preferably comprises the expansion stage and the compression stage, respectively, of a turbocompressor which replaces the primary coolant loop circulating pump of the AGR. As early AGRs are generally designed to operate at a relatively low pressure it may be necessary to insert onto the AGR vessel, after removal of the reactor internal parts, a second vessel that is able to withstand the high pressures inherent to gas cooled breeder reactors.

2849 **Improvements relating to electromagnetic pumps.** Davidson, D.F. (to UKAEA). British Patent 1,413,304/B/. 12 Nov 1975. 6p.

Reference is made to electromagnetic pumps suitable for use in pumping molten Na, and particularly to annular linear induction pumps that may for example be used to pump molten Na at temperatures up to 650° in situations where it is not possible to provide cooling. Previous designs of such pumps have employed disk-shaped coils around the outside of the annulus, the coils being energised from a three-phase power supply to produce a travelling radial field. The pump system described obviates the necessity for joints between the coils. It also allows the use of all types of high temperature insultation, simplified manufacture, and enables the windings to be located on the inside of the annulus. Full constructional details are given.

2850 **Means for supporting nuclear fuel.** Cocker, P.; Price, M.A. (to British Nuclear Fuels Ltd., Risley). British Patent 1416333/B/. 3 Dec 1975. 5p.

Reference is made to means for supporting nuclear fuel pins in a reactor coolant channel and the problems that arise in this connection. For reasons of nuclear reactivity and neutron economy parasitic material in a reactor core must be kept to a minimum, while for heat transfer reasons the use of fuel pins of large cross-sectional areas should be avoided. Fuel pins tend to be long thin objects having a can of minimum thickness and typically a pin may have a length/diameter ratio of about 500/1 and for fast reactor fuel pins, the outside diameter may be about 0.2 inch. The long slender pins must also be spaced very close together. A fast reactor fuel assembly may involve 200 to 300 fuel pins, each a few tenths of an inch in diameter, supported end on to coolant flowing up a channel of about 22 square inches in total area. The pins have a heavy metal oxide filling and require support. Details are given of a suitable method of support. Such support also allows withdrawal of pins from a fuel channel after irradiation without the risk of breach of the can.

2851 **The reprocessing demand under the aspect of the introduction of fast breeder reactors.** Gasteiger, R.; Papp, R. (Kernforschungszentrum Karlsruhe (F.R. Germany). Inst. fuer Angewandte Systemanalyse). pp 826-828 of In Reactor conference, Duesseldorf, 30.3.-2.4.1976. Section 4: Reactor concepts and economics. Eggenstein-Leopoldshafen, F.R. Germany; ZAED (1976). (In German)

From Reactor meeting; Duesseldorf, F.R. Germany (30 Mar 1976).

2 figs.; 6 refs. Short communication only.

2852 (BNWL-tr—187) **Annual report of the Fuel-Rod and Fuel-Assembly Mechanics Working Group of the Reactor Engineering Institute of the Darmstadt Engineering College.** Fabian, H.; Krugmann, U.; Lassmann, K.; Schwarz, R. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Projekt Schneller Brueter; Technische Univ. Darmstadt (Germany, F.R.). Fachgebiet Reaktortechnik). Apr 1976. Translation of KFK—2274. 136p. Dep. NTIS $6.00.

An account of activities on fuel-rod and fuel-assembly mechanics performed by IRT and sponsored by the Fast Breeder

Project of GfK is presented. These activities can be broken down into studies of the integral fuel rod (URANUS computer program), multidimensional studies relying on the finite element method (FINEL and ZIDRIG computer programs) and studies based on the theory of shells. In addition to these subjects a capacitive measurement and evaluation method is reported for the experimental investigation of fuel-assembly cladding tubes by means of internal and external pressure and theoretical work is described which has been carried out by IRT in the field of fracture mechanics.

2853 Effect of corner radius on hexcan deformation. Petroski, H.J. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* **23**: 338-339(Jun 1976).
From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2854 Safety-related analysis of fuel cracking in advanced fuel elements. Kramer, J.M.; Deitrich, L.W. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* **23**: 344-345(Jun 1976).
From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2855 Interactions of refractories and reactor materials with sodium. Fink, J.K.; Heiberger, J.J.; Kumar, R.; Blomquist, R. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* **23**: 365(Jun 1976).
From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2856 Environmental effects on materials performance of LMFBR primary piping. Weeks, J.R.; Klamut, C.J. (Brookhaven National Lab., Upton, NY). *Trans. Am. Nucl. Soc.;* **23**: 380(Jun 1976).
From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2857 Mechanical properties of LMFBR piping materials. Brinkman, C.R.; Sikka, V.K.; King, R.T. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.;* **23**: 380-381(Jun 1976).
From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2858 Defect growth rates in austenitic stainless steels. James, L.A. (Hanford Engineering Development Lab., Richland, WA). *Trans. Am. Nucl. Soc.;* **23**: 381(Jun 1976).
From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2859 Probabilistic assessment of primary piping integrity. Zemanick, P.P.; Witt, F.J.; Sacramo, R.F. (Westinghouse Electric Corp., Madison, PA). *Trans. Am. Nucl. Soc.;* **23**: 382(Jun 1976).
From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2860 Probabilistic criteria for crack inspection. Derby, S.L.; Hackford, N.E.; Temme, M.I. (General Atomic Co., Sunnyvale, CA). *Trans. Am. Nucl. Soc.;* **23**: 382-383(Jun 1976).
From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2861 Fatigue crack growth morphology and critical crack sizes in LMFBR piping and elbows. Begley, J.A. (Ohio State Univ., Columbus); Wilson, W.K.; Sheinker, A.A. *Trans. Am. Nucl. Soc.;* **23**: 383-384(Jun 1976).
From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2862 Corrosion effects and detection of a sodium leak in LMFBRs. Taylor, G.R.; Matheys, W.L. (Westinghouse Electric Corp., Madison, PA). *Trans. Am. Nucl. Soc.;* **23**: 384(Jun 1976).
From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2863 Efficiency analysis to a mesh-packed sodium cold trap. Murase, M.; Sumida, I.; Kotani, K.; Yamamoto, H.; Doi, A. (Hitachi, Ltd., Kanagawa, Japan). *Trans. Am. Nucl. Soc.;* **23**: 386(Jun 1976).
From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2864 Experimental observation of thermal oscillations in LMFBR steam generator tubes. France, D.M.; Chiang, T.; Carlson, R.D. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* **23**: 386-387(Jun 1976).
From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2865 Influence of initial leak rates on the fail-safety of LMFBR steam generator systems. Chopra, P.S.; Stone, C.C.; Srinivas, S. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* **23**: 387-388(Jun 1976).
From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2866 Dynamic simulation to analyze water-to-sodium leaks in LMFBR steam generators. Saphier, D. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* **23**: 388-389(Jun 1976).
From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

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From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

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From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2870 Concept of steam generation with heat pipes for LMFBR applications. Kirk, C.D. (Southwestern Public Service Co., Amarillo, TX); Fulford, P.J. *Trans. Am. Nucl. Soc.;* **23**: 402(Jun 1976).
From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2871 Solid-conductor primary steam generator for LMFBR plants. Adkins, C.R. (Westinghouse Electric Corp., Madison, PA); Gross,M.C.; Harris, W.G.; Vatter, W.J. *Trans. Am. Nucl. Soc.;* **23**: 402-403(Jun 1976).
From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

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From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

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From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2884 Economic comparison of grid and wire-wrap spacers for LMFBR service. Lamb, R.G.; Feerick, B.T. (General Electric Co., Sunnyvale, CA). *Trans. Am. Nucl. Soc.*; **23**: 439-440(Jun 1976).
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2885 Early-life changes in the power to melt of LMFBR fuel rods. Harbourne, B.L.; Hopkins, O.M.; Stephen, J.D. (General Electric Co., Sunnyvale, CA). *Trans. Am. Nucl. Soc.*; **23**: 446(Jun 1976).
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2891 Fractional releases of xenon tag and fission gas from defective elements in EBR-II. So, B.Y.C.; Lambert, J.D.B. (Argonne National Lab., IL); Ebersole, E.R. *Trans. Am. Nucl. Soc.*; **23**: 472-473(Jun 1976).
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2893 Use of ($^{131}Xe/^{134}Xe$) ratio to distinguish between defective uranium and plutonium-bearing elements in EBR-II. Lambert, J.D.B. (Argonne National Lab., IL); So, B.Y.C.; Laug, M.T. *Trans. Am. Nucl. Soc.*; **23**: 474-475(Jun 1976).
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2895 Sodium purification by cold trapping at EBR-II. Holmes, J.T.; Smith, C.R.F.; Wrightson, M.M.; Olson, W.H. (Argonne National Lab., Idaho Falls, ID). *Trans. Am. Nucl. Soc.*; **23**: 487-488(Jun 1976).
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2898 Effective simulator for analyzing neutronic property of fast reactors. Takeda, T. (Hitachi, Ltd., Kanagawa, Japan). *Trans. Am. Nucl. Soc.*; **23**: 541-542(Jun 1976).
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2899 Experimental study of the reactivity effect of steam entry in a simulated GCFR Assembly. Bhattacharyya, S.K.; McKnight, R.D. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.*; **23**: 561-562(Jun 1976).
From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

POWER REACTORS, AUXILIARY, MOBILE, PACKAGE, AND TRANSPORTABLE

REFER ALSO TO CITATION(S) 3363

2900 (LA-UR—76-998) **Heat pipe nuclear reactor for space power.** Koenig, D.R. (Los Alamos Scientific Lab., N.Mex. (USA)). 1976. Contract W-7405-Eng-36. 22p. (CONF-760906—14). Dep. NTIS $3.50.

From 11. intersociety energy conversion engineering conference; State Line, Nevada, United States of America (USA) (12 Sep 1976).

A heat-pipe cooled nuclear reactor has been designed to provide 3.2 MW(t) to an out-of-core thermionic conversion system. The reactor is a fast reactor designed to operate at a nominal heat pipe temperature of 1675°K. Each reactor fuel element consists of a hexagonal molybdenum block which is bonded along its axis to one end of a molybdenum, lithium vapor, heat pipe. The block is perforated with an array of longitudinal holes which are loaded with UO_2 pellets. The heat pipe transfers heat directly to a string of six thermionic converters which are bonded along the other end of the heat pipe. An assembly of 90 such fuel elements forms a hexagonal core. The core is surrounded by a thermal radiation shield, a thin thermal neutron absorber and a BeO reflector containing boron loaded control drums.

REGULATION AND LICENSING

REFER ALSO TO CITATION(S) 3161

2901 **Complying with audit requirements.** Lescisin, J.J. (Westinghouse Electric Corp., Pittsburgh). *Trans. Am. Nucl. Soc.*; **23**: 395-396(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2902 (FIND-STN—50546) **FIND: Marble Hill Nuclear Generating Station, Units 1 and 2.** Moore, M.M. (ed.). (Nuclear Regulatory Commission, Washington, D.C. (USA)). Jun 1975. 18p. Dep. NTIS $3.50.

An index is presented for the docket report material submitted in conjunction with the application for a nuclear power plant construction permit and operating license. The index citations are to the beginnings of major headings, sections, responses, etc., and refer to grid coordinates on microfiche sheets prepared for each docket report. (DG)

2903 (NRCI—76/6) **Nuclear Regulatory Commission issuances.** (Nuclear Regulatory Commission, Washington, D.C. (USA)). Jun 1976. 222p. (NTISUB/B/142—76/006). NTIS.

This report includes the issuances received during the specified period from the Commission (CLI), the Atomic Safety and Licensing Appeal Boards (ALAB), and the Atomic Safety and Licensing Boards (LBP).

2904 (NUREG—0099) **Preparation of environmental reports for nuclear power stations.** (Nuclear Regulatory Commission, Washington, D.C. (USA)). Jul 1976. 99p. (REG/G—4.2(Rev.2)(7-76)). NTIS $5.00.

Guides for the standard format and content of environmental reports for nuclear power plants are presented.

2905 (NUREG/PRDI—76/7) **Power Reactor Docket Information.** (Nuclear Regulatory Commission, Washington, D.C. (USA)). Jul 1976. 89p. TIC $3.50.

Citations and subject indexing to the documentation associated with civilian nuclear power plants are presented. This material is that which is submitted to the U.S. Nuclear Regulatory Commission support of applications for construction and operating licenses. Citations are listed by Docket number in accession number sequence. The Table of Contents is arranged both by Docket number and by nuclear power plant name. (DG)

2906 (NUREG/PRDI—76/8) **Power Reactor Docket Information.** (Nuclear Regulatory Commission, Washington, D.C. (USA)). Aug 1976. 57p. TIC $3.50.

A listing of citations and subject indexing for documentation associated with the regulation of commercial nuclear facilities is presented. This documentation for the most part is that submitted to the U.S. Nuclear Regulatory Commission in accordance with regulatory processes in support of applications for construction permits and operating licenses. The citations are listed in Docket Number order. The citations are preceded by two tables of contents that allow the correlation of Docket Numbers and Facility Names. An alphabetic subject index follows the citations.

2907 (RDT-STATUS—7-76) **Status report, April 1, 1976—June 30, 1976.** (Energy Research and Development Administration, Washington, D.C. (USA). Div. of Reactor Development and Demonstration). 20 Jul 1976. 33p. RSO.

The July 1976 Status Report of RDT Standards covering the period of April 1, 1976 through June 30, 1976 is presented.

2908 (REG/G—1.108(8-76)) **Periodic testing of diesel generators used as onsite electric power systems at nuclear power plants.** (Nuclear Regulatory Commission, Washington, D.C. (USA). Office of Standards Development). Aug 1976. 7p. NUREG.

The regulatory guide presented describes a method acceptable to the NRC staff for complying with the Commission's regulations with regard to periodic inspection and testing of diesel electric power units to ensure that the diesel electric power systems will meet their availability requirements.

2909 (REG/G—1.118(6-76)) **Periodic testing of electric power and protection systems.** (Nuclear Regulatory Commission, Washington, D.C. (USA). Office of Standards Development). Jun 1976. 3p. NUREG.

2910 (REG/G—1.119(06-76)) **Surveillance program for new fuel assembly designs.** (Nuclear Regulatory Commission, Washington, D.C. (USA). Office of Standards Development). Jun 1976. 6p. NUREG.

The guide presented describes a surveillance program acceptable to the NRC staff for determining the performance of new fuel assembly designs. The program may include postirradiation destructive examination if deemed necessary. The guide applies only to those light-water-cooled fuel assemblies incorporating new design features that have been deemed significant by the NRC staff.

2911 (REG/G—2.4(7-76)) **Review of experiments for research reactors.** (Nuclear Regulatory Commission, Washington, D.C. (USA). Office of Standards Development). Jul 1976. 4p. NUREG.

The guide presented describes procedures acceptable to the NRC staff for the licensee's review and approval of experiments performed at research reactor facilities.

2912 (REG/G—185(Rev.7)(8-76)) **Code case acceptability: ASME Section III materials.** (Nuclear Regulatory Commission, Washington, D.C. (USA). Office of Standards Development). Aug 1976. 7p. NUREG.

The regulatory guide presented lists those Section III ASME Code Cases oriented to reactor coolant pressure boundary component materials and testing that are generally acceptable to the NRC staff for implementation in the licensing of light-water-cooled nuclear power plants.

2913 **Guidelines on the atomic licensing procedures for nuclear power plants to check required information.** *IRS Kurz-Inf., Reihe C*; **36**: No. 18, 1-10(1975). (In German).

A compilation of the required information to test the site, containment, reactor protection system and pressure vessels in the atomic licensing procedures for nuclear power plants is given.

2914 **3. amendment to the Atomic Energy Act. Information by the Federal Council. Bulletins 7/2183, 7/2538, 7/3125. Appeal to the Mediation Committee.** *Bundesrat - Drucksache;* No. 7;3269, 1-2(1975). (In German).

The German Bundesrat has appealed to the Mediation Committee in order to enforce some changes in the Third Amendment to the Atomic Energy Act passed by the German Bundestag. The main points of change are: 1) The indemnification by the Bund as stated in paragraph 36 of the Atomic Energy Act will be carried by the Bund alone, without participation of the Federal Land in which the nuclear plant causing the nuclear incidence is situated; 2) the licenses for the operation of fuel element factories granted under paragraph 9 of the Atomic Energy Act before the effective date of said Act will continue to be valid under paragraph 7 of the original version of the Atomic Energy Act.

2915 **The peaceful exploitation of nuclear energy in the FRG. Answer to the interpellation.** *Bundesrat - Drucksache;* No. 7;3871, 1-10(1975). (In German).

The full wording of the answer of the Federal Minister of the Interior in the name and on behalf of the Federal Government is presented.

2916 Notice of amendments to the statutes of the Nuclear Energy Agency (NEA). *Bundesanzeiger;* **27**: No. 157, 3(Aug 1975). (In German).

Short communication only.

2917 Standards of assessment for nuclear power plant sites. *Umwelt* (*Inf. Bundesminist. Innern*); No. 43, 6-13(Sep 1975). (In German).

The licensing and supervising authorities of the German states responsible for the implementation of the Atomic Energy Act and the Federal Minister of the Interior have agreed in the states Committee for Nuclear Energy on November 11th, 1975, on the concerted application of the present 'Standards of assessment for the characteristics of nuclear power plant sites from the point of view of safety and radiation protection' in the selection and assessment of nuclear power plant sites in the frame of long-term site provision. They also advise other institutions dealing with site selection to make use of these standards in their planning.

2918 Australian Atomic Energy Commission: A case study in Australian science and government. Moyal, A.M. (New South Wales Inst. of Tech., Broadway (Australia)). *Search;* **6**: No. 9, 365-384(Sep 1975).

No major scientific body in Australia has evoked as much questioning, criticism and speculation as the Australian Atomic Energy Commission, which was established in 1953 and which, 21 years later, still stands poised on the threshold of bringing Australia into the nuclear age. It is argued that the AAEC has not consolidated the goals and purposes which were set for it over two decades ago. This study attempts to answer the following questions: 1) Is the AAEC a viable institution or is it a white elephant; 2) Has it a rationale and a future in the present age; 3) Has it been accountable or has it evolved, expanded, reorganised, changed direction, consumed funds, used and produced talent, and ultimately marked time behind closed political and administrative doors; 4) Why have its work, its accomplishments and failures not been subjected to public scrutiny.

2919 Commissioning of thermal power stations in the FRG 1974-1978. *Atomwirtsch., Atomtech.;* **20**: No. 11, 571(Nov 1975). (In German).

5 tabs. Short communication only.

2920 Information for the investigation of nuclear power plant sites. New BMI regulations for the facilitation and standardization of the licensing procedures. *Atomwirtsch., Atomtech.;* **20**: No. 11, ang p. 3-4(Nov 1975). (In German).

A list of information for the application for the licensing of a planned nuclear power station in the various stages of the procedure (new regulatory guide by the Federal Ministry of the Interior is presented.

2921 The liability of the owner of a nuclear facility under the amendment to the Atomic Energy Act. Stucken, G. (Institut fuer Reaktorsicherheit der Technischen Ueberwachungs-Vereine e.V., Koeln (F.R. Germany)). *Atomwirtsch., Atomtech.;* **20**: No. 11, 572-574(Nov 1975). (In German).

Under the 3rd amendment to the Atomic Energy Act, which entered into force on October 1, 1975, not only the provisions of the Paris and Brussels Nuclear Liability Conventions have become binding law in the Federal Republic of Germany, but also other changes relating to the liability of the owner of a nuclear facility have become effective. On the whole, the new liability provisions greatly improve and expand the protection of victims. Major changes, inter alia, include legal channeling, the extended physical area of application, the higher maximum liability limit and liability coverage, and certain limits of damages.

2922 No halt to the construction of Muelheim-Kaerlich nuclear power station. *Energiewirtsch. Tagesfragen;* **25**: No. 11, 537-541(Nov 1975). (In German).

15 refs.

The grounds upon which the judgment of Koblenz Administrative Court (Verwaltungsgericht) of 1-8-1975 - 7 L 14/75 - was based are now available. In this decision, the action of the city of Neuwied for restitution of the action to set aside (motion to stay the immediate execution of) the First Partial License for the construction of the 1,200 MW nuclear power station at Muelheim-Kaerlich was dismissed. The costs of the administrative procedures, including the extra-judicial costs of the persons summoned to appear in court, are imposed upon the applicant. The cost in litigation of the procedures following the motion to stay proceedings was fixed at 50,000 DM. The sometimes contradictory grounds of paragraph II are given in full wording and commented upon.

2923 No halt to the construction of Wyhl nuclear power station. *Energiewirtsch. Tagesfragen;* **25**: No. 11, 541-556(Nov 1975). (In German).

10 refs.

On 8-10-1975 - X 351/75 -, the Higher Administrative Court (Verwaltungsgerichtshof) of Baden-Wuerttemberg, in modification of the order of Freiburg Administrative Court (Verwaltungsgericht) of 14-3-1975, under final sentence dismissed the action of 3 communities and 5 private persons for restitution of the suspensive power of the actions to set aside the first partial license for the construction of KKW Sued Block I (about 1,300 MW) in the community of Wyhl insofar as the immediate execution of the erection of the buildings including the reactor building as ordered in the partial license is confirmed under final sentence. The binding force of the site decision connected with the partial license, especially for further partial licenses, on the other hand, remains in suspense, the decision being reserved to the main administrative procedure. As for the rest, the appeal of the applicants (ASt) was dismissed. The decision covers 83 pages. The major points of the decision are presented.

2924 Nuclear Regulatory Commission issuances. Volume 2. Opinions and decisions of the Nuclear Regulatory Commission with selected orders, July 1, 1975—December 31, 1975. Washington, DC; Nuclear Regulatory Commission (1976). 1088p. (NP—20991). GPO $13.00.

Issuances of the Nuclear Regulatory Commission and its Atomic Safety and Licensing Boards and Atomic Safety and Licensing Appeal Boards from July 1 through December 31, 1975 are presented.

2925 (REG/G—1.96(Rev.1)(6-76)) Design of main steam isolation valve leakage control systems for boiling water reactor nuclear power plants. (Nuclear Regulatory Commission, Washington, D.C. (USA). Office of Standards Development). Jun 1976. 5p. NUREG.

2926 (REG/G—1.64(Rev.2)(6-76)) Quality assurance requirements for the design of nuclear power plants. (Nuclear Regulatory Commission, Washington, D.C. (USA). Office of Standards Development). Jun 1976. 2p. NUREG.

2927 Cost/benefit aspects of appendix I to 10CFR50. Bell, M.J.; Hewitt, W.M. (Nuclear Regulatory Commission, Washington, DC). *Trans. Am. Nucl. Soc.;* **23**: 425(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2928 Is the appendix I cost-benefit analysis worth the effort. Vance, J.N.; Tosetti, R.J. (Becthel Power Corp., San Francisco). *Trans. Am. Nucl. Soc.;* **23**: 425-426(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2929 Why 10CFR100 is not cost effective. Boorboor, F. (Long Island Lighting Co., Hicksville, NY). *Trans. Am. Nucl. Soc.;* **23**: 450-451(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2930 (REG/G—1.52(Rev.1)(7-76)) Design, Testing, and maintenance criteria for engineered-safety-feature atmosphere cleanup system air filtration and adsorption units of light-water-cooled nuclear power plants. (Nuclear Regulatory Commission, Washington, D.C. (USA). Office of Standards Development). Jul 1976. 11p. NUREG.

The guide identifies methods acceptable to the NRC staff for implementing the Commission's regulations in Appendix A to 10 CFR Part 50 with regard to the design, testing, and maintenance criteria for air filtration and adsorption units of atmosphere cleanup systems in light-water-cooled nuclear power plants. This guide applies only to engineered-safety-feature atmosphere cleanup systems designed to mitigate the consequences of postulated accidents. It addresses the atmosphere cleanup system, including the various components and ductwork, in the postulated DBA environment.

2931 (REG/G—1.84(Rev.4)(8-76)) Code case acceptability: ASME Section III design and fabrication. (Nuclear Regulatory Commission, Washington, D.C. (USA). Office of Standards Development). Aug 1976. 7p. NUREG.

The regulatory guide presented lists those Section III ASME Code Cases oriented to reactor coolant pressure boundary component design and fabrication that are generally acceptable to the NRC staff for implementation in the licensing of light-water-cooled nuclear power plants.

ECONOMICS

2932 (FRNC-R—37) **Energy consumed and energy supplied by a nuclear power station.** (Electricite de France, 75 - Paris). 24 Feb 1975. 7p. (In French). INIS.

In the building and fuel supply of a nuclear power station, energy is required for the working of materials, the machining, transport and mounting of equipment and the reprocessing of spent fuels. Although the point should not be over-stressed it is interesting to compare these quantities of energy with that produced by the station during operation. The results obtained were established with a lower energy price limit. In views of the mode of calculation it follows that the energy consumed to produce nuclear energy is over-estimated.

2933 (Juel—1203) **Alternative possibilities of development in the power economy of the FRG. Study with the aid of a simulation model.** Rath-Nagel, S. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Programmgruppe Systemforschung und Technologische Entwicklung; Technische Hochschule Aachen (Germany, F.R.)). Jun 1975. 150p. (In German). INIS.

Thesis. 89 figs.; 21 tabs.; 134 refs.

In the investigation presented, problem areas of the energy supply such as reserves, reliability of supply, environmental pollution, and investment and financial questions are discussed. The author tries to represent quantitatively the boundary conditions of the energy supply system of the German Federal Republic and the cause-effect relations determining the energy market. A simulation model consisting of coupled differential equations is developed which is able to demonstrate the variations of the energy economic structure of supply and demand under various external conditions. There is in particular a close analysis of the strength of feedback between energy consumption and economic growth, the effects of various modes of supply under abnormal conditions, and of realizable alternative supply patterns during the investigatory period.

2934 (Juel—1230) **The energy input in the construction and operation of nuclear power stations.** Kolb, G.; Niehaus, F.; Rath-Nagel, S.; Voss, A. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Programmgruppe Systemforschung und Technologische Entwicklung). Aug 1975. 73p. (In German). INIS.

14 figs.; 32 tabs.; 21 refs.

The production of electric power requires energy investments not only for direct fuel input but for the construction of power plants and for the extraction of primary energy fuels as well. When the overall energy balance of energy converting systems has to be assessed, these energetic investments must be included. In the present investigation the overall energy input of different nuclear power plant types (comprising the nuclear fuel cycle) is computed and compared with a coal-fired plant. Moreover a time-dependent energy balance for the expansion of nuclear capacity according to the existing nuclear programs is calculated. Even applying only light water reactors the nuclear expansion program (with an installed capacity of 50 GW(e) in 1985 and 170 GW(e) in 2000) would result in an accumulated fossil fuel saving of approximately the tenfold amount of primary energy consumed in the Federal Republic of Germany yearly today.

2935 **Investment and its financing.** Hausner, O. (Bayernwerk A.G., Muenchen (F.R. Germany)). pp 22-26 of In The electricity industry in the Federal Republic of Germany. Eymueller, T.; Uebbing, H.; Boecker, H. (comps.). Frankfurt am Main, F.R. Germany; Institut fuer Bilanzanalysen (1975). (In German)

1 fig.; 1 tab.

A numerical estimate of the capital demand of the public electricity supply 1974-1985 (according to the VDEW statistics) is reproduced and discussed. Based on the momentary capital market situation, details of financing are described. A comparison between degressive and advanced depreciation is drawn up.

2936 **Financing and insurance problems.** Laurenge, M.-T. *Rev. Gen. Nucl.;* **1**: No. 3, 189-193(Jul 1975). (In French).

The author analyses the papers presented at the Paris Conference on the maturity of nuclear energy. It is evident that financing possibilities will be a determinant factor in the rate of development of nuclear power during the years to come. After having evaluated the capital requirements necessitated for the development of nuclear programmes, the parties intervening have examined the means at the disposal of electricity manufacturers to meet these needs (self-financing, recourse to external financing, regrouping, on an international scale of the electricity manufacturers of the setting up of high capacity plants). As concerns the insurance problems, they are becoming more and more involved as nuclear applications, are further diversified and intensified.

2937 **Energy consumption of a nuclear power plant: 11% of its power production.** *Rev. Energ.;* **26**: No. 277, 895-896(Oct 1975). (In French).

The energy balance of a 1000MW nuclear power plant is established: the energy produced by the plant during its life and the energy required for its construction and its operation are evaluated.

2938 **Energy balance for electricity from nuclear power plants. How much energy is required for the construction and operation of nuclear power plants.** Borsch, P. *VDI (Ver. Dtsch. Ing.) Nachr.;* **29**: No. 42, 1-2(Oct 1975). (In German).

1 fig.

A report is given on the necessary energy expenditure to erect and operate nuclear power plants on the basis of the net efficiency of individual types of power plants. The balance shows positive values since 1967. The building of nuclear power plants in the FRG is considered to be feasible from this aspect.

2939 **Energy needs for nuclear reactor fabrication.** Charpentier, J.P. *Rev. Energ.;* **26**: No. 277, 892-894(Oct 1975). (In French).

The operation time required for a nuclear power plant to repay the energy used for its construction, including the fuel cyle is investigated. The energy deficit duration is determined according to various options of nuclear programs.

2940 **Energy balance of nuclear energy development.** Hollomon, J.H.; Raz, B.; Treitel, R. (Massachusetts Inst. of Tech., Cambridge (USA)). *Rev. Energ.;* **26**: No. 277, 884-891(Oct 1975). (In French).

An expanding electricity production system is investigated in order to evaluate its energy balance at every time of its operation life. By using an energy accountancy and a simple model approach, different choices can be estimated. In a simplification aim, the choices are limited to a comparison between nuclear energy and oil.

2941 **Successful nuclear energy. Progress even in conventional power stations. Report from the VGB annual meeting.** Lenz, W. *VDI (Ver. Dtsch. Ing.) Nachr.;* **29**: No. 45, 6-8(Nov 1975). (In German).

Short communication only.

2942 **Heat extraction for district heating from nuclear power plants.** Schueller, K.H. *Brown Boveri Rev.;* **63**: No. 1, 34-41(Jan 1976).

In thermal power plants used for a combination of electrical power generation and heat production, the electrical output and the heat required from the fuel, are dependent upon: -the amount of heat to be supplied, e.g. for district heating -the specified temperature level of the heat carrier -the layout of plant for the extraction of heat and -the thermal efficiency of the superimposed condensing process. For the purposes of this article the thermodynamic relationships of power plants with steam turbines used for heating can be adequately represented and derived from simplified assumptions and idealized process concepts. The choice of plant layout for the extraction of heat for district heating purposes from nuclear heating power plants is primarily determined by economic factors and technological criteria of the process. It is also dependent upon the requirements of the particular case. Heating steam can be extracted from the crossover pipes between the turbine cylinders or from the turbine bleeds, a district heating system, or special heating turbines can be provided in the steam cycle of the nuclear plant. The economics of a nuclear power plant designed for the supply of electricity and heat are improved by installing an additional high-output gas turbine set with a waste-heat boiler to cover the requirements of peak load and break-downs. During refuelling periods in the nuclear plant the gas turbine set takes over the supply of district heating and also generates some of the electrical output.

CONSTRUCTION AND OPERATION

2943 **Economy in the energy sector - a cooperative effort.** Holtzendorff-Fehling, W. von (Verband der Energie-Abnehmer e.V., Hannover (F.R. Germany)). *Energie;* **27**: No. 10, 35-36(Oct 1975). (In German).

1 fig.

VEA, the Verband der Energie-Abnehmer e.V., states its aims and tasks, defines its attitude regarding the present energy policies of the FRG, and sheds light upon the problems of financing the construction of nuclear power plants.

2944 **On the economic efficiency of nuclear heat power plants.** Cernjaev, V.A.; Rybacev, V.V.; Makarov, V.E.; Sokolov, E.Ja.; Bunin, V.S. *Arch. Energiewirtsch.;* **29**: No. 11, 1057-1067(Nov 1975). (In German).

6 figs.; 4 refs. Translated from Russian Teploehnergetika (1975) v. 22(3) p. 9-13.

The comparable degrees of efficiency and the profitableness of the different variants of nuclear thermal power plants based on the power reactor projects developed in the Soviet Union are examined in the present investigation. The main object of the investigation consists in the determination of a rational region of the thermal efficiencies for a nuclear thermal power plant as well as of the initial parameters of the energy cycle concerned.

2945 Engineers contribution to nuclear fueled generating station availability and operability. Sailer, W.F. (Gilbert/Commonwealth Associates, Inc., Jackson, MI). *Trans. Am. Nucl. Soc.*; **23**: 407-408(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2946 What nuclear plant reliability really means to the utility. Wethy, C.M. (Florida Power and Light Co., Miami). *Trans. Am. Nucl. Soc.*; **23**: 408(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2947 Architect/engineer's part in availability improvement. Shor, S.W.W. (Bechtel Power Corp., San Francisco, CA). *Trans. Am. Nucl. Soc.*; **23**: 409(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2948 It's time we set the record straight. Rossin, A.D. (Commonwealth Edison Co., Chicago). *Trans. Am. Nucl. Soc.*; **23**: 443-444(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

FUEL CYCLE

REFER ALSO TO CITATION(S) 2466, 2472, 3322

2949 (INIS-mf—2085) **Uranium resources and the scope for nuclear power.** Vaughan, R.D. (Combustion Engineering Association, London (UK)). 1975. 16p. (CONF-751167—2). INIS.

From The Combustion Engineering Association conference on energy for tomorrows world; Eastbourne, United Kingdom of Great Britain and Northern Ireland (UK) (25 Nov 1975).

The subject is discussed under the following headings: uranium resources, forecast on nuclear program, avenues for reduction in uranium consumption, uranium consumption for fixed programme with various breeders, and possible nuclear growth determined by uranium supply.

2950 Fuel cycle. Sousselier, Y. (CEA Direction des Productions, 92 - Chatillon (France)). *Rev. Gen. Nucl.*; **1**: No. 3, 178-182(Jul 1975). (In French).

The papers presented at the Paris Conference on the maturity of nuclear energy are analyzed. The main questions relating to the reprocessing of fuels are recalled and the considerable progress made in this field is presented. The problems posed by the enrichment of uranium are not the technical development of the processes but concern the development of industrial capacities for the separation of isotopes. It should be looked to the industrial field to make this effort as the future of nuclear power depends on it.

2951 Optimum fuel enrichment as seen by the operational warranty. Stojadinovic, A. (Internationale Atomreaktorbau G.m.b.H. (INTERATOM), Bensberg/Koeln (F.R. Germany)). *Atomwirtsch., Atomtech.*; **20**: No. 9, 415-418(Sep 1975). (In German).

4 figs.; 4 tabs.

A method for the optimization of fuel enrichment is developed which on the one hand helps to avoid a too high overenrichment, and, on the other hand, prevents penalties. The unclearness of the effective multiplication factor and of the penalty value to be expected are essential parameters enabling a statement on the optimum trust limit.

2952 Nuclear fuel cycle costs: present uncertainties. Geller, L. (S.M. Stoller Corp., Boulder, CO). *Trans. Am. Nucl. Soc.*; **23**: 443(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2953 Light water reactors, breeders, and abundant energy. Dietrich, J.R. *Combustion;* **48**: No. 1, 25-28(Jul 1976).

From Conference of Japan section of American Nuclear Society; Tokyo, Japan (20 Nov 1975).

Brief comments and data are presented concerning fuel cycle economics of breeder operation and plutonium recycle. (DG)

PROCESS HEAT REACTORS

REFER ALSO TO CITATION(S) 2276, 3200

2954 (COO—2477-2(Rev.1)) **Engineering evaluation of process heat applications for very high temperature nuclear reactors.** Wiggins, D.S.; Williams, J.J. (United Engineers and Constructors, Inc., Philadelphia, Pa. (USA)). 9 Mar 1976. Contract AT(11-1)-2477. 145p. Dep. NTIS $6.00.

Coal gasification and liquefaction processes and costs are reviewed. Nuclear-heated processes based on 3000-MWt reactors are compared to the principal fossil-heated coal conversion processes of similar size. The published processes are technically feasible, and costs are consistent with United Engineers' experience. If a 15 percent fixed charge rate and $0.50/10^6 Btu coal can be obtained, and costs published by proponents of these processes are valid: (1) coal can be converted to pipeline gas at a cost competitive with unregulated natural gas; (2) coal can be converted to heavy naphtha and heavy oils at a cost competitive with the present cost of imported oil; (3) synthesis gas ($CO + H_2$) obtained from coal can be converted to methanol significantly cheaper than the current market price; and (4) synthesis gas is also attractive for the reduction of iron ore. The costs of coal conversion are very sensitive to the fixed charge rate and the coal costs, and may not be competitive for higher values. At low coal costs, nuclear-heated processes are more expensive than fossil-heated. At high coal costs, nuclear processes become less expensive than coal. The applicability of nuclear-heated coal conversion is limited because the size of the plant is too great for many mine-mouth operations. Much smaller fossil-heated plants can be built without a significant increase in product cost.

2955 (Juel—1191) **Comparative study for endenergy supply with nuclear district heating and with nuclear long distance energy.** Dietrich, G. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Programmgruppe Systemforschung und Technologische Entwicklung; Technische Hochschule Aachen (Germany, F.R.)). Jul 1975. 169p. (In German). INIS.

Thesis. 75 figs.; 24 tabs.; 163 refs.

The future energy supply of the Federal Republic of Germany will be orientated to secure energy carriers. Moreover economical energy consumption and environmental protection will be a force for an increased application of district heating and nuclear long distance energy. The technics of generation, transport and distribution of the two energy carriers will be discussed, besides a short review of application areas and potentials. The cost comparisons by models show that there are special advantages for both systems. Nevertheless the conclusions from the study can be to favour nuclear long distance energy because of its wide application range in the whole heat market. But there is also the competition with combined heat and power generation on fossil basis, as practiced in many industrial companies. As a result of a regional analysis of the area Aachen-Moenchengladbach-Koeln, the cost advantages of the nuclear long distance energy as a parameter of current prices are confirmed. Nuclear long distance energy, in combination with the high temperature reactor and a developed technic of catalysts up to temperatures of 900 K, is an energy source which will be independant of regional necessities, secure, non pollutant and economic.

2956 (LIB/Trans—554) **Closed circuit energy supply.** Schulten, R.; Barnert, H. Translated by U. Engelbert from *VDI* (*Ver. Dtsch. Ing.*) *Ber.*; **224**: 25-35(1974). 18p. Dep. NTIS (US Sales Only) $3.50.

The petroleum crisis has made evident the necessity to employ nuclear energy to an increasing degree in the power supply of the nonelectrical market. For this purpose it is desirable to convert nuclear energy into transportable and readily accessible forms of energy. This can be achieved by the conversion of nuclear energy into the chemical energy of a latent heating gas circulating between the nuclear power plants and the consumers of energy. The nuclear heat source of this energy supply system described as Nuclear Long Distance Energy is the high temperature reactor.

2957 Synthesis of hydrocarbons using coal and nuclear process heat. Eickhoff, H.G.; Kugeler, K. (Kernforschungsanlage Juelich G.m.b.H. (F.R. Germany)). *Erdoel Kohle, Erdgas, Petrochem.*; **28**: No. 8, 375-379(Aug 1975). (In German).

5 figs.; 4 tabs.; 35 refs.

An analysis of global petroleum resources and demand shows that the amount of petroleum products is sufficient to meet the requirements of the next decades. The geographical resources, however, could lead to problems of distribution and foreign exchange. The production of hydrocarbons with coal as basis using high temperature nuclear process heat has advantages compared to the conventional techniques. Next to the conservation of reserve fossil primary energy carriers there are advantages as regards prices, which at high coal costs are especially pronounced.

2958 Considerations on heat transport of high powers from a heat-electric station into a congested area. Linder, F. (Stadtwerke Muenchen (F.R. Germany). Elektrizitaetswerke). *Fernwaerme Int.*; 4: No. 4, 146-149(Sep 1975). (In German).

From 5. general meeting and lecture meeting of the Arbeitsgemeinschaft Fernwaerme e.V. of the Vereinigung Deutscher Elektriziteatswerke e.V.; Muenchen, F.R. Germany (14 May 1975).

When considering the transport of heat from nuclear heat-electric stations into congested areas, questions arise which have not yet become urgent in cases of district-heating supply. The transport of large quantities of heat over distances of 30 to 50 km requires careful consideration of such long lines, particularly from the cost point of view. The laying under ground or above ground of pipes of the order of 1,000 to 1,500 pmm diameter, including the shut-off devices and expansion arrangements, requires careful planning. Further, the heating media, steam or hot water, give rise to special problems. The author reports on the possible transport of heat up to 2,000 Gcal/h.

2959 Basic ideas for a congested area. Power and district heating in a base area from a heat-electric station. Schaech, R. (Stadtwerke Muenchen (F.R. Germany). Maschinentechnische Planungsabteilung). *Fernwaerme Int.*; 4: No. 4, 139-146(Sep 1975). (In German).

From 5. general meeting and lecture meeting of the Arbeitsgemeinschaft Fernwaerme e.V. of the Vereinigung Deutscher Elektrizitaetswerke e.V.; Muenchen, F.R. Germany (14 May 1975).

8 figs.; 2 tabs.

From investigations for a specific case of supply the author draws conclusions which are more or less generally applicable, and fixes limitations. It is a case of supply to a congested area with a maximum district-heating demand of about 2,300 Gcal/h. In view of the standardisation of nuclear stations a process of generation has to be aimed at which makes possible flexible matching to demand over the life of the installation. In the case of district heating supply from a heat-electric station the distance from the station to the centre of gravity of supply plays an important part. Here the author makes comparisons of different variants form the points of view of size of heat-electric station, type of cooling and heat carrier, in dependence on the distance of the heat-electric station. In addition he lists the problems in the use of the heat carriers hot water and steam in relation to generation in the heat-electric station and transmission over a distance.

2960 Present questions and problems in district-heating supply. Winkens, H.P. (Energie- und Wasserwerke Rhein-Neckar A.G., Mannheim (F.R. Germany)). *Fernwaerme Int.*; 4: No. 4, 130-134(Sep 1975). (In German).

From 5. general meeting and lecture meeting of the Arbeitsgemeinschaft Fernwaerme e.V. of the Vereinigung Deutscher Elektrizitaetswerke e.V.; Muenchen, F.R. Germany (14 May 1975).

2 figs.

District-heating supply has now become of interest to the general public since its applications via heat-electric stations has resulted in considerable savings in energy and a power supply which protects the environment. For power and heat supply to congested areas nuclear power stations will become more important. But independent of this the construction and operation of heat-electric stations of conventional design is economical and requisite. This must not be hindered by the new emission law. The immediate aim must be to set up new connections in areas which already have district-heating supply, in particular by means of the oil central-heating installations which are available in large numbers. The District-heating Committee of the VDEW has put forward proposals for promoting district heating to the Federal Government. The author reports on the studies put in hand by the Government.

2961 District-heating supply from nuclear stations. Dietrich, G. (Kernforschungsanlage Juelich G.m.b.H. (F.R. Germany). Programmgruppe Systemforschung und Technologische Entwicklung); Kaier, U. (Kraftanlagen A.G., Heidelberg (F.R. Germany)); Solfrian, W. (Bonnenberg und Drescher Ingenieurgesellschaft m.b.H., Juelich (F.R. Germany)). *Fernwaerme Int.*; 4: No. 5, 155-162(Oct 1975). (In German).

12 figs.; 1 tab.; 2 refs. The fundamentals have been published under the title 'Einsatzmoeglichkeiten neuer Energiesysteme'.

The unreliability of oil supply at the end of 1973 and the increase in oil prices by 300% have led to a permanent restriction in practically all branches of industry and have required a reorientation in energy supply. The substitution of synthetic oil and other measures to increase the reliability of power supply have therefore become the main aim of efforts in the field of energy supply. Of the measures which have been considered the more important are secondary energy sources which can be produced with the aid of nuclear process heat, such coal refinement products, hydrogen and district heating, as well as the technique which has already been developed for district-heating. The author pays special attention to nuclear power-district heat combination because this will be the first technique to be developed for the application of nuclear process heat.

NUCLEAR REACTOR TECHNOLOGY

THEORY AND CALCULATION

REFER ALSO TO CITATION(S) 4164, 4189

2962 (BNL-NUREG—21241) **Development of solutions to benchmark piping problems.** Reich, M.; Chang, T.Y.; Prachuktam, S. (Brookhaven National Lab., Upton, N.Y. (USA)). Jan 1976. Contract E(30-1)-16. 120p. Dep. NTIS $5.50.

Piping analysis is one of the most extensive engineering efforts required for the design of nuclear reactors. Such analysis is normally carried out by use of computer programs which can handle complex piping geometries and various loading conditions, (static or dynamic). A brief outline is presented of the theoretical background for the EPIPE program, together with four benchmark problems: two for the static case and two for the dynamic case. The results obtained from EPIPE runs compare well with those available from known analytical solutions or from other independent computer programs.

2963 (BNWL—1803) **Numerical model for two-dimensional hydrodynamics and energy transport.** Trent, D.S. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Jun 1973. Contract E(45-1)-1830. 134p. Dep. NTIS $6.00.

The theoretical basis and computational procedure of the VECTRA computer program are presented. VECTRA (Vorticity-Energy Code for TRansport Analysis) is designed for applying numerical simulation to a broad range of intake/discharge flows in conjunction with power plant hydrological evaluation. The code computational procedure is based on finite-difference approximation of the vorticity-stream function partial differential equations which govern steady flow momentum transport of two-dimensional, incompressible, viscous fluids in conjunction with the transport of heat and other constituents.

2964 (IKE—6-64E) **The problem of a digital simulation of Xe oscillations in power reactors.** Elzmann, H.J. (Stuttgart Univ. (TH) (Germany, F.R.). Inst. fuer Kernenergetik). Apr 1974. 79p. (In German). INIS.

22 refs.; with figs.

Xe-induced power oscillations are simulated in a pressurized water reactor. The coupled balance equation for the neutrons and the decay products iodine/xenon are decoupled via a quasi-stationary approach. The stationary multigroup diffusion equation is solved with a difference method. The whole model is realized with the aid of already existing modules of the reactor program system RSYST. Its basic usefulness is established. A further expansion of the method is discussed with the aim to develop rod drive programs for real reactors.

2965 (ITN—101-1975) **The DACC system. Code burnup of cell for projection of the fuel elements in the power network PWR and BWR.** Cepraga, D.; Boeriu, St.; Gheorghiu, E.; Cristian, I.; Patrulescu, I.; Cimporescu, D.; Ciuvica, P.; Velciu, E. (Institutul Pentru Tehnologii Nucleare, Pitesti-Colibasi (Romania)). 1975. 23p. (In Romanian). INIS.

The calculation system DACC-5 is a zero-dimensional reactor physics code used to calculate the criticality and burn-up of light-water reactors. The code requires as input essential extensive reactor parameters (fuel rod radius, water density, etc.). The nuclear constants (intensive parameters) are calculated with a five-group model (2 thermal and 3 fast groups). A fitting procedure is systematically employed to reduce the computation time of the

code. Zero-dimensional burn-up calculations are made in an automatic way. Part one of the paper contains the code physical model and computer structure. Part two of the paper contain tests of DACC-5 credibility for different light-water power lattices.

2966 (ERDA-tr—125, pp 6-10) **Integrated method of calcuating reactor shielding.** Veselkin, A.P.; Gur'eva, N.A.; Netecha, M.E.; Nikitin, A.V. 1974. Translated from pp 7-10 of Voprosy fiziki zashchity reaktorov, vypusk 6, Atomizdat, Moscow, 1974.

In Questions on the physics of reactor shielding. Volume 6.

The NYEGA integrated program for calculating various functionals of the neutron gamma fields in reactor shielding is described. The program contains a library of multigroup constants.

2967 (ERDA-tr—125, pp 11-16) **Using Korobov's method in radiation shielding calculations.** Gogotova, L.F.; Nikitin, A.V. 1974. Translated from pp 10-14 of Voprosy fiziki zashchity reaktorov, vypusk 6, Atomizdat, Moscow, 1974.

In Questions on the physics of reactor shielding. Volume 6.

The Korobov method of optimum coefficients for calculating multiple integrals in shielding calculations is illustrated.

2968 (ERDA-tr—125, pp 17-24) **Using the method of subgroups to allow for the resonance structure of cross-sections in computations of the passage of neutrons through plane layers of shielding.** Germogenova T.A.; Isaev, N.V.; Nikolaev, M.N.; Khokhlov, V.F. 1974. Translated from pp 14-20 of Voprosy fiziki zashchity reaktorov, vypusk 6, Atomizdat, Moscow, 1974.

In Questions on the physics of reactor shielding. Volume 6.

It is shown that the method of subgroups in shielding calculations allows for the resonance structure of cross sections.

2969 (ERDA-tr—125, pp 25-34) **Asymptotic characteristics of the distribution of fast neutron fluxes in heterogeneous shielding.** Germogenova, T.A.; Konovalov, N.V.; Suvorov, A.P. 1974. Translated from pp 20-29 of Voprosy fiziki zashchity reaktorov, vypusk 6, Atomizdat, Moscow, 1974.

In Questions on the physics of reactor shielding. Volume 6.

The problem of the passage of fast neutrons at large distances in plane one-dimensional shield in a single-velocity approximation is discussed.

2970 (ERDA-tr—125, pp 35-45) **Spatial and angular distributions of fast neutrons in conical shielding.** Bass, L.P.; Germogenova, T.A.; Dubinin, A.A.; Khmylev, A.N. 1974. Translated from pp 29-37 of Voprosy fiziki zashchity reaktorov, vypusk 6, Atomizdat, Moscow, 1974.

In Questions on the physics of reactor shielding. Volume 6.

Techniques for the numerical solution of the transfer equations for the spatial and angular distributions of fast neutrons in conical shielding are presented.

2971 (ERDA-tr—125, pp 73-78) **Calculating the temperature field in biological shielding by the method of electrothermal analogy.** Demeshev, R.S.; Rekshnya, N.F. 1974. Translated from pp 59-63 of Voprosy fiziki zashchity reaktorov, vypusk 6, Atomizdat, Moscow, 1974.

In Questions on the physics of reactor shielding. Volume 6.

The calculation of the temperature distribution in the shielding of a power reactor by the method of electrothermal analogy is illustrated.

2972 (ERDA-tr—125, pp 79-87) **Optimum multilayer shadow shielding for a reactor.** Sakovich, V.A.; Sakharov, V.M. 1974. Translated from pp 63-69 of Voprosy fiziki zashchity reaktorov, vypusk 6, Atomizdat, Moscow, 1974.

In Questions on the physics of reactor shielding. Volume 6.

Optimum values of layer thicknesses that would insure minimum shielding weight for a given permissible dose rate in the shielding area are calculated.

2973 (ERDA-tr—125, pp 88-91) **Optimality criterion for the shape of reactor shielding.** Goryachev, I.V.; Kuznetsov, V.G.; Sakovich, V.A. 1974. Translated from pp 69-72 of Voprosy fiziki zashchity reaktorov, vypusk 6, Atomizdat, Moscow, 1974.

In Questions on the physics of reactor shielding. Volume 6.

The optimization of the shape of one of the shield surfaces (while the other has an arbitrary shape) is discussed for the case where the ray method or the method of integrating the radiation emanating from the surface is applicable.

2974 (ERDA-tr—125, pp 127-139) **Passage of neutrons with intermediate energies through shielding with complex irregularities.** Bolyatko, V.V.; Sakharov, V.M.; Suvorov, A.P.; Kharizomenov, Yu.V. 1974. Translated from pp 98-108 of Voprosy fiziki zashchity reaktorov, vypusk 6, Atomizdat, Moscow, 1974.

In Questions on the physics of reactor shielding. Volume 6.

The results of experimental and theoretical investigations of the passage of slow and intermediate neutrons through flat, offset slits in shielding are presented.

2975 (ERDA-tr—125, pp 176-190) **Modern methods and experience of analyses of neutron energy distributions in nuclear reactor experiments.** Egorov, Yu.A.; Pankrat'ev, Yu.V. 1974. Translated from pp 135-146 of Voprosy fiziki zashchity reaktorov, vypusk 6, Atomizdat, Moscow, 1974.

In Questions on the physics of reactor shielding. Volume 6.

Convenient and reliable methods for the determination of neutron energy spectra in reactor experiments are discussed. The methods are useful for reactor physics studies, shielding experiments, or radiation damage studies.

2976 (ERDA-tr—125, pp 217-224) **Analysis of the characteristics of the radiation thermodiverger in stationary operating modes.** Avaev, V.N.; Efimov, E.P. 1974. Translated from pp 165-172 of Voprosy fiziki zashchity reaktorov, vypusk 6, Atomizdat, Moscow, 1974.

In Questions on the physics of reactor shielding. Volume 6.

The use of a radiation thermodiverger in studying radiation heating in reactor core materials and shielding is discussed.

2977 Intervallverteilungsmessungen zur Reaktivitaetsbestimmung an Kernreaktoren. (Interval distribution measurement to determine the reactivity in nuclear reactors). Grenz, G. (Technische Hochschule Aachen (F.R. Germany). Inst. fuer Elektrische Anlagen und Energiewirtschaft). Opladen, F.R. Germany; Westdeutscher Verl. (1975). 85p. (In German).

With figs. and tabs.; 43 refs.

The application of noise analysis to signals of a neutron detector enables the measurement of the reactivity of a subcritical nuclear reactor by means of the Rossi-α determination. The measurement of the distribution density of the intervals between single counter tube pulses is one of the methods for investigating the pulse sequence of a counter tube. The Kolmogoroff theory of the branching processes is first applied to the detection of neutrons using an absorption detector. The reactor kinetic model characterized by monoenergetic neutrons in the point reactor is used as a basis. By introducing probability-creating functions, it is possible to derive three probability densities which are also measurable. It is shown that the Psub(cc) interval distribution measurement has the largest information content where the deviation from the Poisson distribution for non-correlated events is taken as a measure. A study of the determining parameters shows that complications in Psub(cc) measurements are only to be expected for reactivities close to the critical state or at high neutron source intensities. An experiment was set up on the SUR-100 to investigate further parameters influencing the Psub(cc) measurement; its arrangement and date evaluation are described in detail. With this experimental arrangement, measurements could be successfully carried out even at psup(x) = -0.2 dollars whereas the interval distribution measurement described in the literature only went up to about -1.3 dollars near the critical state.

2978 Experiences in the pre-service and in-service inspection of light-water reactors. Watkins, B.; Swithenbank, T.; Jackson, H. (UKAEA Reactor Group, Risley). pp 118-128 of In Periodic inspection of pressurized components. A conference arranged by the Applied Mechanics Group and the Nuclear Energy Group of the Institution of Mechanical Engineers, London, 4-6 June 1974. London; Mechanical Engineering Pub. for Institution of Mechanical Engineers (1975).

From Conference on periodic inspection of pressurized components; London, UK (4 Jun 1974).

Descriptions are given of inspections carried out on the pressure vessels of three light water reactors. For the automated inspections described the main techniques were closed circuit television and ultrasonic testing. The pulse/echo system was used, the results being presented as a B-scan picture. A partial inspection was conducted on the 450 MW(e) BWR Santa Maria de Garona after several years operation the inspection being manual and performed from the outside of the vessel by local removal of insulation panels. The PWR type reactor BR3 was examined after about 10 years operation after removal of reactor internals. Selected areas were examined as being representative of the vessel. The third examination was a pre-service inspection of the Borssele PWR reactor, generally in accordance with ASME Code Section X1 (1971). The planning required for an inspection, i.e. site visits, staff training, and documentation are discussed.

2979 The Pu 240 content of commercial produced plutonium and the criticality of fast assemblies. Suemer, S. (Ege Universitesi, Izmir (Turkey)). *Atomkernenergie;* 27: No. 1, 23-26(1976).

3 figs.; 3 tabs.; 18 refs.

With the help of multigroup Ssub(N) methods neutron balance calculations have been carried out in order to study whether plutonium produced in commercial nuclear power plants is suitable to reach criticality in fast assemblies in spite of the presence of Pu 240. For numerical treatment 100 energy groups and S_8-P_3 approximation have been used by symmetrical sphere geometry. It is shown that the negative effects of Pu 240 are in small scale to prevent prompt criticality. Thus, additional precautions are necessary to prevent such possibilities.

2980 Numerical considerations in the discrete ordinates method for neutronics studies. Vaidyanathan, R.; Krishnan, S.; Shankar Singh, R. (Reactor Research Centre, Kalpakkam (India)). *Atomkernenergie;* **27**: No. 1, 71-72(1976).

2 tabs.; 3 refs.

The discrete ordinates method provides the deterministic solution of the neutron transport equation, using a two-stage iteration strategy. The practical utility of the method has, however, been restricted owing to the large computation time involved. Despite certain favourable numerical trends having been understood by experience, no general guidelines have been set out for the effective utilisation of the method. The following important numerical aspects of the method are studied with respect to a variety of problems to draw generally useful conclusions: choice of suitable trial distributions for inner and outer iterations; relative convergence criteria for the iteration schemes, and use of two convergence acceleration procedures in deep propogation problems.

2981 Some forms of group constants for nuclear reactor calculations. Tinka, I. *Jad. Energ.;* **22**: No. 4, 152-156(Apr 1976). (In Slovak).

The principles are briefly described of processing nuclear data with point representation to group constants with an arbitrary energy distribution. Using suitable computation program systems, libraries of evaluated group constants are processed, and either group constant systems specific for a given reactor or universal microconstant systems for a wider reactor type scope are obtained. The method is described of obtaining energy groups in the 26-group ABBN system based on the so-called subgroup representation of effective cross sections. The diagram is shown of the FEDGROUP program system for nuclear constant processing.

2982 Asymptotic behavior of transmission probabilities for annular regions. Hwang, R.N.; Toppel, B.J. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* **23**: 525-526(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2983 Monte Carlo calculations of neutron transport using the probability table method. Plechaty, E.F. (Univ. of California, Livermore). *Trans. Am. Nucl. Soc.;* **23**: 526(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2984 Monte Carlo diffusion modeling of void effects. Odom, J.P.; Klotzkin, G.; Travelli, A. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* **23**: 527-528(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2985 Calculations for highly compressed microspheres of fissile transuranium isotopes. Krumbein, A.D. (Israel Atomic Energy Commission, Yavne). *Trans. Am. Nucl. Soc.;* **23**: 530-531(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2986 Solution of a nonlinear multigroup problem by Green's Functions. Cintra, W.H. (Instituto de Energia Atomica, Sao Paulo, Brazil). *Trans. Am. Nucl. Soc.;* **23**: 539-540(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2987 Effect of neutron leakage from a three-dimensional reactor on the neutron flux perturbation due to control plates. Morsy, S.; Kamha, E. (Atomic Energy Establishment, Cairo). *Trans. Am. Nucl. Soc.;* **23**: 541(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2988 Analysis of BNL ^{233}U—ThO_2 exponential experiments with ENDF/B—IV data. Sehgal, B.R. (Electric Power Research Inst., Palo Alto, CA); Lin, C.; Rec, J.R.; Hellens, R.L.; Shapiro, N.L. *Trans. Am. Nucl. Soc.;* **23**: 559-560(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

2989 Average energies of β^- particles emitted by fission products. Goldsmith, M.; Shure, K. (Bettis Atomic Power Lab., West Mifflin, PA). *Nucl. Sci. Eng.;* **60**: No. 3, 322-324(Jul 1976).

Values of E/sub av//E/sub max/ for beta particles from fission products obtained by an approximate method developed by England are shown to differ by less than 5 percent from those obtained by including Coulomb effects correctly for E/sub max/ less than or equal to 5.0 MeV.

2990 Importance of the uranium-238 inelastic transfer matrix for fast-reactor analysis. Choong, T.; Kujawski, E. (General Electric Co., Sunnyvale, CA). *Nucl. Sci. Eng.;* **60**: No. 3, 326-329(Jul 1976).

The ^{238}U inelastic scattering was modified to reflect the recently recommended larger values for the 45-keV (2^+) and 146-keV (4^+) levels. The partial inelastic cross sections for the other levels given in ENDF/B-IV between 0.8 and 3.7 MeV were accordingly decreased such as to keep the total inelastic cross section unchanged. To investigate the consequences of these modifications three fast-neutron assemblies have been analyzed. The above modifications result in a general improvement between calculated and measured fast-reactor parameters.

COMPONENTS AND ACCESSORIES

REFER ALSO TO CITATION(S) 2908, 2978, 3458, 3476, 3483, 3485, 3502, 3503, 3513, 3757

2991 (AED-CONF—75-365-030, pp vp.) **Recent developments on dynamics of thermo-elasto-plastic continua for nuclear reactor applications.** Ariman, T. 1975.

From International seminar on extreme load conditions and limit analysis procedures for structural reactor safeguards and containment structures; Berlin, German, Federal Republic of (F.R. Germany) (8 Sep 1975).

169 refs. With abstract. Available from BAM.

In International seminar on extreme load conditions and limit analysis procedures for structural reactor safeguards and containment structures. Suppl. 2.

A concise survey is presented of the recent developments on dynamics of thermo-elasto-plastic continua in relation to metals in nuclear reactor power technology. In recent years this field has seen an increased development influenced by the need to solve practical problems in high-velocity forming of metals, blast loadings, seismically induced vibrations in nuclear reactor technology, and responses of structures or machines to dynamic loads. The field involves many complex problems mainly in connection with the physical foundations in continuum constitutive relationships for large ranges of stress intensity, strain rate and temperature variations, and with the solutions of mostly nonlinear boundary and initial value problems.

2992 (CEA-R—4671) **Linear or/and circular displacement capacity transducers. Study and realization of high resolutive industrial prototypes.** Aulit, J.; Beaudet, J.P. (CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France)). Jul 1975. 63p. (In French). INIS.

Proposals are made about linear or/and circular displacement transducer measurements using a capacity variation method. Absolute measurements are allowed with great accuracy, approximately on micrometer or one thousandth of a degree, for dimensions up to some hundred millimeters, or 360 degrees. A first approach up to millimeters or degrees is given by a classical method (i.e. binary encoded beam). The division of each millimeter is obtained by linear variation of photo engraved capacity on a glass rule and measured by an original capacity via frequency conversion method. In this system, the use of variable frequency signals allows one to achieve remote display and shows great interest for many applications such as space and machine tool applications.

2993 (NCSR-R—4) **The reliability of pneumatic control equipment a case study in mechanical reliability.** Moss, T.R. (UKAEA National Centre of Systems Reliability, Culcheth). 1975. 27p. INIS.

A reliability assessment of automatic feedwater control systems to be installed in a nuclear power station indicated relatively high rates of failure from the pneumatic control equipment. The predictions were, however, at variance with the early operating experience of identical prototype systems installed elsewhere,

and doubts were cast on the validity of the simple exponential model of failure employed in the assessment. These doubts have been largely substantiated. The study indicates that the level of faults potentially hazardous to the reactors is likely to be about a factor of 10 lower than predicted. It is shown that the failures of equipment employed in the systems are initially distributed according to Weibull functions. A constant rate of failure (i.e., simple exponential distribution) will emerge at some stage but it will be dependent of the randomising effects of repeated maintenance rather than the chance combination of stress factors normally associated with failures in the useful-life phase. The majority of mechanical systems in industrial situations are also expected to follow Weibull distributions. The factors which cause this appear to be largely determined by the system's normal loading characteristics. An evaluation of the load function and its effect on individual component lifetime is therefore essential if mechanical equipment failure rates are to be predicted theoretically.

2994 (NCSR-R—5) **Computer determination of event maps with application to auxiliary supply systems.** Wredenberg, L.; Billinton, R. (UKAEA National Centre of Systems Reliability, Culcheth). 1975. 10p. INIS.

A method of evaluating the reliability of sequential operations in systems containing standby and alternate supply facilities is presented. The method is based upon the use of a digital computer for automatic development of event maps. The technique is illustrated by application to a nuclear power plant auxiliary supply system.

2995 (RDT-M—3-16T(4-76)) **Carbon and alloy steel pipe (ASME SA-333 with additional requirements).** (Energy Research and Development Administration, Washington, D.C. (USA). Div. of Reactor Development and Demonstration). Apr 1976. 8p. RSO.

This standard covers carbon and alloy steel pipe for nuclear and associated applications.

2996 (RDT-M—3-18T(4-76)) **Nickel—molybdenum—chromium alloy seamless tubes (ASME SB-163 with additional requirements).** (Energy Research and Development Administration, Washington, D.C. (USA). Div. of Reactor Development and Demonstration). Apr 1976. 9p. RSO.

This standard covers nickel—molybdenum—chromium alloy seamless tubes for nuclear and associated applications.

2997 **Method of production of plane-faced concrete (etc.) bodies, particularly for protective walls in reactor construction.** Borsdorf, H. German(FRG) Patent 1919505/A/. 29 Oct 1970. 9p. (In German).

4 figs.

A method is described for the manufacture of concrete bodies whose size variation is so small that they can be used as protective wall parts in reactor building. A box frame of right-angled angular profiles with possible reinforcing rods which already has the specified accurate measures is used as original body. Plywood panels are used as form which are coated on one side with rubber and are supported on the frames. A contact pressure on the form parts created by an assembly frame produces a sealing effect of the rubber layer against the metal box frame and prevents the concrete from overflowing in the jarring operation of concreting. Furthermore, the rubber layers only produce indentations on the surfaces between the angular profiles which can be levelled out, after the drying process with a filler, e.g. with radiation absorbing properties. Smoothing and polishing then follow.

2998 **A device for the inspection of walls.** Aubert, G.; Lemoine, R.; Maury, A.; Moulin, M.; Tomachevsky, E. (to CEA). French Patent 2,242,750/A/. 27 Aug 1973. 24p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France).

The present invention relates to a device for inspecting the walls of reactor vessels. The device consists of a transducer carrying carriage parallel to the surface to be examined. The carriage is rotated along the walls under examination while ensuring a perfect parallel relation-ship between the transducers and the surfaces to be examined. This can be applied to the inspection of metal walls of difficult access.

2999 **Steam generator.** Andrieu, J.L.; Bonnet, Y.; Verdeau, J.J. (to CEA). French Patent 2,242,897/D/. 28 Aug 1973. 13p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France).

A steam generator is described comprising a tubular plate with holes to which are connected the extremities of the U-tubes of a bundle. The tubes are dipped in a secondary fluid and contain a circulating primary fluid. This generator is characterized in that the extremities of the U-tubes of the bundle are distributed in the tubular plate with a non-constant pitch, the tube portions in which flows the hot primary fluid being arranged with a pitch greater than that of those tube portions in which flows the cold primary fluid. Such an arrangement permits the improved circulation of the secondary fluid in that portion of the bundle in which flows the hot primary fluid, in particular in that portion which is farthest from the secondary-fluid admission peripheral zone.

3000 **A method and device for the collection of solid daughter-products issuing from radioactive gases.** Lavignolle, A.; Lecomte, P.; Le Meur, R.; Recule, A.; Roubier, P. (to CEA). French Patent 2,242,690/A/. 28 Aug 1973. 11p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France).

The present invention relates to a method and device for collecting radioactive products with a view to carrying out analyses. Radioactive gases are caused to pass through the inside of the body of a so-called forming enclosure for an adjustable period of time; the length of the radioactive gas path through the enclosure in which the radioactive isotopes are disintegrated so as to provide solide daughter products is adjusted at will, and the solid daughter products are collected in a removable filter. This is applicable to the analysis of radioactive gases from the cover gas of a nuclear reactor, or fission gases produced and stored in cans wrapping fuel clusters. Such collection allows the detection of leaks in the cans wrapping fuel clusters.

3001 **Ultrasonic-testing method.** Thome, P. French Patent 2244173/A/. 19 Sep 1973. 14p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France).

A description is given of a device adapted to the detection, by means of ultrasonic waves, of all the flaws and defects included in workpieces when only one face of the latter is accessible. A beam is directed towards the rear-face of the workpiece (e.g. a plate) on which it is reflected. The image thus reflected is fed into a receiver. The latter is under the control of the displacement of that image; simultaneously a transducer checks the condition of the mirror at the places where the beam is reflected. Whenever a flaw or defect appears, a silent zone is formed. By recording the silent zones with respect to the positions of several emitters, it is possible to locates a flaw and to define its outline. The apparatus comprises several "emitter-receiver" groups intersecting over the emitter used in order to check the integrity of the mirror. The invention can be used for searching and identifying flaws and defects in buildings which have to be of top quality (e.g., cofferdams, nuclear devices, shipbuilding yards, aeronautics).

3002 (ERDA-tr—125, pp 251-259) **Requirements on concrete and structures of reinforced concrete reactor shield.** Korenevskii, V.V.; Pergamenshchik, B.K.; Perevalov, V.S. 1974. Translated from pp 191-196 of Voprosy fiziki zashchity reaktorov, vypusk 6, Atomizdat, Moscow, 1974.

In Questions on the physics of reactor shielding. Volume 6.

Special requirements are being imposed on reactor shields by having them act also as structural members or heat shields. The operating conditions, shield design, and requirements imposed on the materials and construction are discussed.

3003 (ERDA-tr—125, pp 260-272) **Use of barium-serpentine cement in reactor shields of atomic power plants.** Voskresenskii, E.V.; Egorov, Yu.A.; Zaalishvili, G.G.; Kutateladze, K.S.; Lekishvili, R.A.; Pankrat'ev, Yu.V.; Piskunov, V.I. 1974. Translated from pp 197-206 of Voprosy fiziki zashchity reaktorov, vypusk 6, Atomizdat, Moscow, 1974.

In Questions on the physics of reactor shielding. Volume 6.

Results of studies on the physicomechanical and shielding properties of heat-resistant barium-serpentine and iron—barium—serpentine cements are presented.

3004 **Layout of the measuring instruments used for monitoring the activity in the ventilation stack of nuclear power plants.** Kuhn, L. (Kraftwerk Union A.G., Erlangen (F.R. Germany). Reaktortechnik). *Messtechnik;* **82**: No. 4, 85-90(Apr 1974). (In German).

4 figs.; 4 tabs.; 9 refs.

The paper presented gives a survey of the measuring instruments in use for monitoring the activity in the ventilation stack in nuclear plants. A measuring device is described which fulfills the hitherto known requirements imposed by authorities.

3005 **T-shaped coupling with a thermal sleeve.** Harrington, E.F. Jr. (to Chemetron Corp., Chicago, Ill. (USA)). French Patent 2229010/A/. 7 May 1974. 8p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France); priority claim: 7 May 1973, USA.

A T-junction is described; it has an outer wall structure with a tubular input piece which can be connected to an intake pipe or another container, and an inner thermal sleeve assembled to the outer structure inside the tubular piece in such a way as to form an annular space closed at one end. The distinctive feature of this joint is that the above annular space is closed at another end to stop the circulation of fluid in this space. The joint is designed in particular for the intake of cold water to compensate the high temperature supply water of nuclear reactors.

3006 A gas conditioning and analysis system. Busch, F.R. (to General Electric Co., Schenectady, N.Y. (USA)). French Patent 2245942/E/. 27 Sep 1974. 22p. (In French).

Addition to the french patent document 7231677; Available from Institut National de la Propriete Industrielle, Paris (France); priority claim: 28 Sep 1973, USA.

A system for carrying out a rapid analysis of explosive gas-mixtures is described. This system comprises a conduit connecting a sample taking point to a detection chamber, said chamber containing a mass of liquid into which the gas sample is discharged and being provided with a detecting unit for analyzing gases and with separate gas exit and liquid exit. The liquid is sent to a level-regulating chamber, whereas said gas exit sends the gas to a gas-stopping chamber which is in turn, connected to the conduit leading to a discharge point, and a vacuum pump for drawing up the gas sample into the system. This system can be applied to nuclear power stations.

3007 Importance of fracture in damages leading to the destruction of pressure vessels. Hubert, M.; Julien, M. (Fives-Cail-Babcock, 75 - Paris (France)). pp 11-57 of In 17. Colloquium on metallurgy. Mechanical and metallurgical factors of fracture, particularly in nuclear industry. Saclay, 24-26 June 1974. Saclay, France; Institut National des Sciences et Techniques Nucleaires (1975). (In French)

From 17. Colloquium on metallurgy. Mechanical and metallurgical factors of fracture, particularly in nuclear industry; Saclay, France (24 Jun 1974).

The study of pressure vessel accidents and degradation processes that lead to rupture is very useful to improve the reliability of vessels and accordingly that of nuclear boilers. The accident statistics are very insufficient in France, nevertheless it is possible to classify the accidents in categories and to determine the accident probability in each category. Some cases of accidents and ruptures are analyzed and two of them are particularly discussed.

3008 Mechanical behavior and analysis of pressure vessels and nuclear boilers. Pellissier-Tanon, A. (Societe Creusot-Loire, 75 - Paris (France)). pp 109-137 of In 17. Colloquium on metallurgy. Mechanical and metallurgical factors of fracture, particularly in nuclear industry. Saclay, 24-26 June 1974. Saclay, France; Institut National des Sciences et Techniques Nucleaires (1975). (In French)

From 17. Colloquium on metallurgy. Mechanical and metallurgical factors of fracture, particularly in nuclear industry; Saclay, France (24 Jun 1974).

The mechanical behavior of pressure vessels (especially nuclear boilers) is analyzed as a function of their structure, the stresses which they undergo and the behavior of materials subjected to these stresses. These elements, considered with their consequences on the progress of degradation processes, serve as a basis for the essential principles of computation methods.

3009 Basis for mechanical analysis of structures in nuclear power plants. Roche, R. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service des Etudes Mecaniques et Thermiques). pp 59-108 of In Facteurs mecaniques et metallurgiques de la rupture, notamment dans l'industrie nucleaire. Saclay, France; Institut National des Sciences et Techniques Nucleaires (1975). (In French)

From 17. Colloquium on metallurgy. Mechanical and metallurgical factors of fracture, particularly in nuclear industry; Saclay, France (24 Jun 1974).

Traditional methods based on stress calculations and the notion of permissible stresses do not permit a complete analysis of mechanical structures, especially in industries requiring high operational safety. The elasticity theory cannot be accepted, as it leads to stress calculations without any physical meaning. It is necessary to account for plasticity, but this involves other principles than that of the notion of stress alone. The applicable criteria must be based on structural damage under external action. Several types of damage exist, depending on the structure in question and its operation. Only the most frequent types are discussed here: excessive deformation, instabilities, progressive deformation, progressive cracks (fatigue) and sudden fracture. The recent updating of the French regulations concerning pressure vessels for light water nuclear power plants makes it necessary to analyze these types of damage. Attention must also be paid to the effects of creep and the limitation of local deformation in structures operating at high temperature. Finally, the increasing attention paid to quality control is reported.

3010 The electric boiler: a necessary accessory for nuclear power plants. Stucheli, A. (Sulzer Bros. Ltd., Winterthur (Switzerland)); Chevailler, C. (Compagnie de Constructions Mecaniques (CCM), Procedes Sulzer, 75 - Paris (France)). *Entropie;* **11**: No. 63, 18-35(1975). (In French).

Performance of electric and fossil fuel boilers are compared. Some characteristics: fuel cost, number and efficiency of the devices limiting pollution are presently in evolution. Besides, the multiplication of the number of nuclear power plants and the regulations relating to exhausts of combustion residues in atmosphere allow electric boilers and heat accumulation facilities to be envisaged as economically viable in 1980. Examples of electric boiler exploitation are given: electrode-equipped boiler for the remote-heating Marienstrasse der technische Werke Stuttgart, multiple jet boiler fitting the nuclear power plant ENEL IV at Caorso (Italy), and the boilers equipped with electrodes planned for Bugey, 2,3,4 and 5.

3011 Preliminary investigation of ultrasonic shear wave holography with a view to the inspection of pressure vessels. Aldridge, E.E.; Clare, A.B.; Shepherd, D.A. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). pp 72-77 of In Periodic inspection of pressurized components. A conference arranged by the Applied Mechanics Group and the Nuclear Energy Group of the Institution of Mechanical Engineers, London, 4-6 June 1974. London; Mechanical Engineering Pub. for Institution of Mechanical Engineers (1975).

From Conference on periodic inspection of pressurized components; London, UK (4 Jun 1974).

The manner in which holography would fit into the general scheme of pressure vessel inspection is discussed. Compared to conventional A, B, and C presentations holography requires a different processing of the ultrasonic signal and a mechanical scan which may be more demanding than that normally provided for a C display. Preliminary results are presented of the examination of artificial defects in steel plate using shear wave holography.

3012 Stress wave emission monitoring: assessment, correlation and calibration. Bartle, P.M. (Welding Inst., Cambridge (UK)). pp 37-45 of In Periodic inspection of pressurized components. A conference arranged by the Applied Mechanics Group and the Nuclear Energy Group of the Institution of Mechanical Engineers, London, 4-6 June 1974. London; Mechanical Engineering Pub. for Institution of Mechanical Engineers (1975).

From Conference on periodic inspection of pressurized components; London, UK (4 Jun 1974).

Stress wave emission monitoring for the determination or prediction of behavior or properties of materials, joints, or structures requires the proving of equipment and techniques. Work over the past three years has allowed requirements in this respect to be more clearly defined. The factors which have been found to define system requirements are outlined, and early equipment is reviewed in the light of these needs. An essential requirement is that a high degree of correlation between the assessed value of the emission detected and the significance of the events producing the emission be established. Developments towards meeting system requirements are described and results indicating that the necessary correlation can be obtained are discussed. The basic needs for standardization of assessment techniques and calibration procedures is emphasized and other outstanding problem areas are highlighted.

3013 Acoustic emission monitoring of a pressure vessel. Birchon, D.; Dukes, R.; Taylor, J. (Admiralty Materials Lab., Poole (UK)). pp 88-94 of In Periodic inspection of pressurized components. A conference arranged by the Applied Mechanics Group and the Nuclear Energy Group of the Institution of Mechanical Engineers, London, 4-6 June 1974. London; Mechanical Engineering Pub. for Institution of Mechanical Engineers (1975).

From Conference on periodic inspection of pressurized components; London, UK (4 Jun 1974).

Results of some defect location studies on a pressure vessel are reported and correlated with those of ultrasonic inspection. Good agreement was observed, with a probability greater than 90% that a defect location detected would be confirmed by ultrasonics. This good agreement is considered to result from the use of peak sensing rather than the more commonly used leading edge triggering technique. Attention is drawn to the influence of the defect extension process upon the ease of detection, contrasting the difficulty of detecting slow crack growth with the ease of detection of pulses originating from the fracture of hard particles or their

separation from the matrix, and to the influence of the Kaiser effect, which can mean that a flaw may not be detectable unless previously applied stress levels are exceeded, or that flaw growth has occurred since the previous inspection, or that some metallurgical recovery process has operated.

3014 Steam generator and condenser tubing nondestructive inspection by the eddy current method. Dau, G.J.; Libby, H.L. (Pacific Northwest Power Group, Richland, Wash. (USA)). pp 59-65 of In Periodic inspection of pressurized components. A conference arranged by the Applied Mechanics Group and the Nuclear Energy Group of the Institution of Mechanical Engineers, London, 4-6 June 1974. London; Mechanical Engineering Pub. for Institution of Mechanical Engineers (1975).

From Conference on periodic inspection of pressurized components; London, UK (4 Jun 1974).

The eddy current method for nondestructive testing of tubing is reviewed and present needs for the inspection of steam generator and condenser tubing are discussed. The multiparameter eddy current approach to the tubing inspection problem is described, and laboratory results are given showing the detection of tubing flaws in the presence of simulated tube supports. Further possibilities of the method are delineated, and future direction of development of the eddy current method for the inspection of tubing in nuclear plants is discussed.

3015 A review of fracture mechanics methods for assessing the integrity of pressurized structures. Heald, P.T.; Edmondson, B. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). pp 95-99 of In Periodic inspection of pressurized components. A conference arranged by the Applied Mechanics Group and the Nuclear Energy Group of the Institution of Mechanical Engineers, London, 4-6 June 1974. London; Mechanical Engineering Pub. for Institution of Mechanical Engineers (1975).

From Conference on periodic inspection of pressurized components; London, UK (4 Jun 1974).

Different methods for assessing critical defect sizes in pressurized structures, covering linear elastic and post yield fracture mechanics and the Irvine stress concentration approach, are considered. The differences which are important in practice are highlighted. The Irvine approach is shown to have certain similarities to the other methods.

3016 On developing new rules for ultrasonic examination of welds in nuclear vessels. Hedden, O.F. (Combustion Engineering, Inc., Windsor, Conn. (USA)). pp 7-110 of In Periodic inspection of pressurized components. A conference arranged by the Applied Mechanics Group and the Nuclear Energy Group of the Institution Of Mechanical Engineers, London, 4-6 June 1974. London; Mechanical Engineering Pub. for Institution of Mechanical Engineers (1975).

From Conference on periodic inspection of pressurized components; London, UK (4 Jun 1974).

In March, 1972 the ASME Subgroup on Inservice Inspection appointed a Task Group to develop new requirements for ultrasonic examination of nuclear vessels, the existing ASME Code requirements having been found insufficiently definitive. The resulting document, Appendix 1 to Section X1 of the Code, concentrates heavily on extensive on-site calibration. In addition, it requires measurement of flaw location and through thickness dimension, as well as length, and excuses the operator from the responsibility of determining the character of the flaw. Some of the anomalies in ultrasonic examination which led the Task Group to severely restrict the examination techniques are also described.

3017 Acoustic holographic imaging - a method for evaluating defects in thick-walled pressure vessels. Holt, A.E. (Babcock and Wilcox Co., Lynchburg, Va. (USA). Research and Development Div.). pp 185-197 of In Periodic inspection of pressurized components. A conference arranged by the Applied Mechanics Group and the Nuclear Energy Group of the Institution of Mechanical Engineers, London, 4-6 June 1974. London; Mechanical Engineering Pub. for Institution of Mechanical Engineers (1975).

From Conference on periodic inspection of pressurized components; London, UK (4 Jun 1974).

Practical application of acoustical holographic imaging as a useful non-destructive evaluation technique on thick-walled vessels is discussed. The non-destructive evaluation techniques used throughout industry, and especially those applied to nuclear power plant components, are required to provide more precise characterization of defects than is sometimes possible by conventional inspection techniques. Acoustical holography is an evaluation technique which can greatly enhance the characterization of defects in thick-walled pressure vessels. The primary objective of the experimental work reported was to develop techniques for using acoustical holography in shop and field applications. Data and results obtained from a shop evaluation on an actual thick-walled pressure vessel, as well as supporting laboratory studies on test standards, are reported. Reconstructed images from artificial and actual defects are compared.

3018 Documentation of data acquisition. Lautzenheiser, C.E.; Grothues, H.L.; Lamm, D.A.; Hamlin, D.R. (Southwest Research Inst., San Antonio, Tex. (USA)). pp 153-161 of In Periodic inspection of pressurized components. A conference arranged by the Applied Mechanics Group and the Nuclear Energy Group of the Institution of Mechanical Engineers, London, 4-6 June 1974. London; Mechanical Engineering Pub. for Institution of Mechanical Engineers (1975).

From Conference on periodic inspection of pressurized components; London, UK (4 Jun 1974).

Nondestructive examination of nuclear power systems requires comprehensive documentation of the inspection process so that system integrity and test reproducibility are assured. Inspection codes require baseline examination of all welds within the inspection boundary prior to system operation so that subsequent comparisons can be made throughout the life of the plant. Experience has emphasized the necessity of complete and accurate records to fulfil these requirements.

3019 Limiting influences on the reliability of ultrasonic in-service inspection methods. Wuestenberg, H. (Bundesanstalt fuer Materialpruefung, Berlin (F.R. Germany)); Mundry, E. pp 108-113 of In Periodic inspection of pressurized components. A conference arranged by the Applied Mechanics Group and the Nuclear Energy Group of the Institution of Mechanical Engineers, London, 4-6 June 1974. London; Mechanical Engineering Pub. for Institution of Mechanical Engineers (1975).

From Conference on periodic inspection of pressurized components; London, UK (4 Jun 1974).

The ultrasonic method of flaw detection for in-service inspection of nuclear power plant components is discussed. Specific techniques for ultrasonic testing for internal flaws in different geometric positions are considered, followed by an examination of ultrasonic methods for defects near the surface. A number of difficulties based on special reactor pressure vessel conditions are discussed. Problems are then considered which arise from the characteristics of the ultrasonic method itself, which, for in-service inspection, can affect the reliability of the method. The need for relatively high test sensitivities (which cannot be defined by the dimensions of flaws proposed by fracture mechanics considerations), and the necessity for developing all possible methods of a quantitative description of reflectors, are emphasised.

3020 The influence of ASME Section X1 and EEI-RP on in-service inspection. Bailey, E.C. (Commonwealth Edison Co., Chicago, Ill. (USA)); Reinhart, E.R. pp 176-183 of In Periodic inspection of pressurized components. A conference arranged by the Applied Mechanics Group and the Nuclear Energy Group of the Institution of Mechanical Engineers, London, 4-6 June 1974. London; Mechanical Engineering Pub. for Institution of Mechanical Engineers (1975).

From Conference on periodic inspection of pressurized components; London, UK (4 Jun 1974).

The collaborative work of the Edison Electric Institute and other interested groups in developing non-destructive testing methods for inservice inspection of nuclear power pressure components, and the influence of ASME Code Section X1, are discussed. Reasearch Project EEI-RP-79 was carried out using as a test facility an unused pressure vessel provided by USAEC. The planning of the program, the techniques used, and the results are described. The program was successful in demonstrating the feasibility of on-line acoustic emission monitoring, in advancing the art of ultrasonic inspection, and in developing and demonstrating the technique of acoustic holography for heavy wall inspection. Some future applications are also considered.

3021 Evaluation of heavy section vessels using acoustic techniques. Lautzenheiser, C.E.; Greer, A.S. Jr.; Jolly, W.D.; Ying, S.P. (Southwest Research Inst., San Antonio, Tex. (USA)). pp 146-152 of In Periodic inspection of pressurized components. A conference arranged by the Applied Mechanics Group and the Nuclear Energy Group of the Institution of Mechanical Engineers, London, 4-6 June 1974. London; Mechanical Engineering Pub. for Institution of Mechanical Engineers (1975).

From Conference on periodic inspection of pressurized components; London, UK (4 Jun 1974).

During the past five years, Southwest Research Institute has maintained a very active research and development program designed to meet the continuing need to improve inspection techniques. The Institute has been especially active in the areas of acoustic emission, acoustic holography, acoustic spectrometry and advance ultrasonics. Practical results of this reasearch are

presented along with some discussion on application of NDT technology to nuclear power systems.

3022 Augmented scope of the 1974 ASME Section X1 code 'In-service inspection of nuclear power plant components'. Johnson, W.P. (Yankee Atomic Electric Co., Westboro, Mass. (USA)); Bush, S.H.; Maccary, R.R. pp 29-36 of In Periodic inspection of pressurized components. A conference arranged by the Applied Mechanics Group and the Nuclear Energy Group of the Institution of Mechanical Engineers, London, 4-6 June 1974. London; Mechanical Engineering Pub. for Institution of Mechanical Engineers (1975).

From Conference on periodic inspection of pressurized components; London, UK (4 Jun 1974).

The major revisions and additions to ASME code Section X1 introduced since 1971 and incorporated into the 1974 Code are described. The specific changes include: functional testing of pumps and valves; expansion to cover components in ASME Code classes 2 and 3; ultrasonic examination procedures (Appendix I); standards for examination evaluation; evaluation of flaw indications (Appendix A) and repair procedures. A major addition is the establishment of acceptance - rejection levels. Future additions include inspection of reactor core internals and component supports for LWRs and inspection of gas cooled and liquid metal cooled plants.

3023 Waermetechnische Abnahmeversuche an Dampfturbinen. VDI-Dampfturbinenregeln. (Thermal acceptance tests of steam turbines. VDI rules of steam turbines). Berlin, F.R. Germany; Beuth (Feb 1975). 32p. (In German). (DIN—1943).

15 figs.; 4 tabs.; 32 refs.

Uniform rules are presented for the preparation, the carrying-out, and the evaluation of acceptance tests. It also stipulates the conditions under which the acceptance tests have to take place. The standard allows for unambiguous and clear arragements between orderer and supplier, and it is therefore to be considered binding by the contracting parties. Deviations and supplementations are to be arranged separately.

3024 Fuelling and discharge system for spherical fuel elements of a nuclear reactor. Pugh, J. (to Commission of the European Communities, Brussels (Belgium)). German(FRG) Patent 1539931/B/. 28 May 1975. 4p. (In German).

7 figs.

A fuelling and discharge system for spherical fuel elements of a nuclear reactor is described which enables the introduction and removal of the sensitive fuel elements in the fuel channels of the reactor core to be controlled without damaging them. The fuelling system is for a reactor whose core has parallel arranged pairs of fuel channels being connected to each other at one end; it is connected to one of the free ends of the channel pairs, i.e., one end connected to the fuelling system and the other to the discharge system. Both of the free ends of the fuel channels have sphere catches and both of the charging devices have a movable ram to release these sphere catches. The arrangement is described in detail.

3025 Electromotor control rod drive for nuclear reactors. Baker, S.M. (to Royal Industries, Inc., Pasadena, Calif. (USA)). German(FRG) Patent 2029256/B/. 28 May 1975. 7p. (In German).

7 figs.

The positioning of a control rod arranged in a pressure vessel takes place with a drive. This protrudes out of the pressure vessel through a support and is formed from a rotating field motor with energy source, e.g. alternating current connection. Its stator surrounds a section of a pressure casing which covers the length of the drive. The rotor is arranged in the pressure casing and interacts with a shaft lying in the rotation axis. Furthermore, segments are hinged on it, each of which forms two arms of a rocker. Each segment can be revolved against are storing force in a plane containing the rotation axis, through the stator field acting on one of the rocker arms. In order that the drive motor is automatically blocked should the electricity supply fail, the other rocker arm can be connected with a fixed cased component of the drive having the effect of a friction break or a form-locking mechanical catch.

3026 Steam generators for nuclear power plants. Tillequin, J. (Fives-Cail-Babcock, 75 - Paris (France)). *Tech. Mod.*; **67**: No. 7, 29-33(Jul 1975). (In French).

The role and the general characteristics of steam generators in nuclear power plants are indicated, and particular types are described according to the coolant nature (carbon dioxide, helium, light water, heavy water, sodium).

3027 Experimental determination of a flow model in a plate exchanger. Fontaine, J.; Lannoy, F. (Liege Univ. (Belgium)). *Rev. Gen. Therm.*; **14**: No. 164, 573-579(Aug 1975). (In French).

Starting from the conductivimetric measurement of the response of a plate exchanger to a stepped input signal, two techniques (i.e. one direct and one indirect) for the determination of the coefficients of the mathematical model describing the behaviour of the exchanger are compared. The results show that these coefficients can be obtained with a sufficient accuracy by the direct reading of two parameters of the response curve. Variation of these coefficients with rated conditions show, moreover that the phenomenon is not linear and that these coefficients must be considered as variable parameters.

3028 Fracture of reactor pressure vessel steels. Radon, J.C.; Glover, A.P.; Johnson, F.A. (Imperial Coll. of Science and Technology, London (UK). Dept. of Mechanical Engineering). *Materialpruefung;* **17**: No. 9, 319-321(Sep 1975).

2 figs.; 8 refs.

In the present work dynamic toughness values, K(1d), have been obtained for A533B steel, by using an instrumented impact technique. This steel has been specially developed for pressure vessel application. Two different impact speeds were used in order to compare the results with a K(1d) vs K plot of slower rate data from other sources. The testing programme was carried out over a range of temperatures, from -197°C to +100°C. Dynamic yield results were obtained from impact three point bend tests on standard Charpy notched bar specimens.

3029 Nuclear power plant with emergency ejection of reactor core. Pedrick, A.P. British Patent 1,414,286/B/. 19 Nov 1975. 4p.

An arrangement is described whereby if, for some reason, a nuclear reactor core becomes dangerously hot it can be ejected to a position in a deep underground shaft, wherein there is little risk of the escape of radioactivity to the surface. Ejection is preferably by explosive means, and following ejection the shaft is sealed off.

3030 Cooling nuclear reactor fuel. Porter, W.H.L. (to UKAEA). British Patent 1416184/B/. 3 Dec 1975. 5p.

Reference is made to water or water/steam cooled reactors of the fuel cluster type. In such reactors it is usual to mount the clusters in parallel spaced relationship so that coolant can pass freely between them, the coolant being passed axially from one end of the cluster in an upward direction through the cluster and being effective for cooling under normal circumstances. It has been suggested, however, that in addition to the main coolant flow an auxiliary coolant flow be provided so as to pass laterally into the cluster or be sprayed over the top of the cluster. This auxiliary supply may be continuously in use, or may be held in reserve for use in emergencies. Arrangements for providing this auxiliary cooling are described in detail.

3031 Reactor vessel support. Shebanova, L.E.; Kirilyuk, N.A.; Vikhorev, Yu.V.; Zholdak, G.I.; Dubrovskij, V.B. German(FRG) Patent 116977/D/. 12 Dec 1975. 9p. (In German).

A reactor vessel support installed within the biological shield is described. It consists of radially arranged and closely bound cantilever supporters. The space between the supporters is filled up with concrete. The invention is aimed at improving in-service inspections of the reactor vessel material by creating a space of sufficient dimensions between the vessel and its support.

3032 Pressurized vessel for water-cooled nuclear reactors. Wall, N.G.S. (to Aktiebolaget Atomenergi, Stockholm (Sweden)). Swedish Patent document 7506895-7/B/. 22 Dec 1975. 5p. (In Swedish).

A pressurized vessel is described for water cooled nuclear reactors comprising an outer vessel of pre-stressed concrete an inner-vessel containing the reactor containers and filled with steam at least in the upper portion thereof and devices adapted to maintain in the space between said two vessels a gas (e.g. nitrogen) pressure slightly higher than the steam-pressure within inner-vessel the latter being provided with a removable cover resting on the wall of vessel characterized by the fact that ducts are provided for introducing water into the space between said cover and the vessel wall, so as to reduce leakage of gas from space toward the inside of the inner vessel.

3033 Stresses of anisotropic structure plates consisting of cylindrical shells. I. Theory. Kuzelka, V. (Statni Vyzkumny Ustav pro Stavbu Stroju, Bechovice (Czechoslovakia)). *Jad. Energ.*; **22**: No. 4, 132-140(Apr 1976). (In Czech).

A method was developed of determining the deflection surface and the stresses in structural anisotropic plates composed of cylindrical shells. A cylindrical shell whose free ends are exposed to various types of an asymmetric radial surface load is considered. The obtained equations are used in solving the problem in matrix form suitable for the cascade procedure of numerical solutions by a computer. The application of the present method may be found in various fields, especially in nuclear reactor structure studies.

The method is not limited to one type of boundary edge conditions or to plates of constant thickness. The method makes possible the solutions of plates with variable thicknesses with different boundary edge conditions. The method is also not limited to normal loads. The loads may by arbitrary including the aero-hydrodynamic loads. The method makes possible the design of the plates of optimum shape with a view to using a minimum of structural material.

3034 Study sheds new light on whether increased packing height seals a nuclear valve better. Champagne, R.P. *Power (N.Y.);* **120**: No. 5, 72-73(May 1976).

The results of a recent study suggest that the use of packing rings beyond a reasonable limit can lead to stem wear and overload troubles without giving additional assurance against leaks.

3035 (NR-tr—002) Acoustic emission method for tracing crack propagation in pressure vessels. (Japan Atomic Energy Research Inst., Tokyo; Central Research Inst. of Electric Power Industry, Tokyo (Japan); Tokyo Univ. (Japan). Inst. of Industrial Science). Jun 1976. Translation of JAERI-Memo—5753. 182p. NTIS $7.50.

A hemispherical model and a pressure vessel model were used as samples. In the former model, artificial notches were fabricated at the top. In the latter, two types of artificial notches were fabricated at the points of origin of the maximum stress (corners of the inner surface of the nozzles) in four nozzles with different shapes which were mounted on the model proper. The AE method was used to investigate the process of crack initiation and propagation from these artificial notches by means of repeated loading with internal pressure. It was possible to obtain from the results of these tests much useful data concerning the properties of AE and the points of origin of AE (positional tracking) when cracks are initiated and propagated in structures having complex shapes such as these samples. Simultaneously with the measurements by the AE method, Smek gages and crack gages mounted on the nozzle corners were used to investigate the crack initiation and propagation behavior. It was established that there is a close connection between them.

3036 Optimal inspection of pressure vessel welds. Solomon, K.A. (NUS Corp., Sherman Oaks, CA). *Trans. Am. Nucl. Soc.;* **23**: 394(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3037 Evaluation of the eddy-current method of inspecting steam generator tubing. Flora, J.; Brown, S. (Battelle Memorial Inst., Columbus, OH). *Trans. Am. Nucl. Soc.;* **23**: 394-395(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3038 Equipment for handling uranium hexafluoride in cavity reactor and plasma experiments. Jaminet, J.F.; Kendall, J.S. (United Technologies Research Center, E. Hartford, CT). *Trans. Am. Nucl. Soc.;* **23**: 403-404(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3039 Thermal-hyraulic investigations of a roughened rod array. Eaton, T.E. (Univ. of Kentucky, Lexington); Lanning, D.D.; Todreas, N.E. *Trans. Am. Nucl. Soc.;* **23**: 410-411(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3040 Thermal analysis of reactor support system. Hensler, R.; Iotti, R.C.; Scully, R. (Ebasco Services, Inc., New York). *Trans. Am. Nucl. Soc.;* **23**: 415(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3041 Progress in development of a practical method for in-situ response time testng of platinum resistance thermometers. Kerlin, T.W. (Univ. of Tennessee, Knoxville); Mott, J.E.; Warner, D.C.; Hashemian, H.M.; Arendt, J.S.; Gentry, T.S.; Cain, D.G. *Trans. Am. Nucl. Soc.;* **23**: 428(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3042 Self-powered flux detectors: status and prospects. Kroon, J.C. (Reuter-Stokes, Inc., Cleveland); Smith, F.M.; Taylor, R.I. *Trans. Am. Nucl. Soc.;* **23**: 459-460(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3043 Special requirements for pipeline systems of nuclear power stations. Thies, J. *Combustion;* **48**: No. 1, 29-32(Jul 1976).

Stress analysis requirements and methods for nuclear piping design as specified by the ASME code are discussed. (DG)

FUEL ELEMENTS

REFER ALSO TO CITATION(S) 3516, 3518, 3519, 3520, 3521, 3522, 3531, 3534, 3535, 3542, 3543, 3544, 3545, 3546, 3547, 3549, 3550

3044 (KFK—2091) Calculation of vapor pressures of oxide fuels up to 5,000 K for equilibrium and nonequilibrium evaporation. Breitung, W. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Neutronenphysik und Reaktortechnik; Kernforschungszentrum Karlsruhe (Germany, F.R.). Projekt Schneller Brueter). Jun 1975. 61p. (In German). INIS.

13 figs.; 4 tabs.; 34 refs.

The evaporation kinetics of multicomponent systems is studied with UO_3 as the example. The evaporation, which is generally incongruent, implies that two opposing types of steady-state evaporation must be distinguished: equilibrium evaporation and forced congruent evaporation. The two types of evaporation indicated entail different vapor pressures. In some prompt critical reactor incidents forced congruent evaporation must be anticipated. Vapor pressures of UOsub(2+-x) and (U,Pu)Osub(2+-x) are calculated for both types of evaporation up to a temperature of 5,000 K. The calculating procedures are based on the method of Rand and Markin (1967) incorporating recent thermodynamic data. The agreement between the measured and calculated total pressures is good for the ranges of temperature and stoichiometry for which experimental results are available. This supports the results calculated for higher temperature ranges.

3045 (NUREG—0085) Analysis of fuel densification. Meyer, R.O. (Nuclear Regulatory Commission, Washington, D.C. (USA). Office of Nuclear Reactor Regulation). Jun 1976. 78p. NTIS $5.00.

A chronology is given of NRC reviews of analytical models that are used by U.S. fuel manufacturers for the analysis of fuel densifications. A new NRC densification model, which is based on a 1700°C-24 hr resintering test and non-instantaneous kinetics, is also described. Statistical methods are presented for applying the model to production quantities of fuel. The NRC densification model is being used in licensing activities, but it was not developed with the intention of replacing approved vendor models.

3046 (TRG-REPORT—2682(R)) PERCON: a flexible computer code for detailed thermal performance studies. Boardman, F.B.; Collier, W.D. (UKAEA Reactor Group, Risley). Jul 1975. 29p. INIS.

Available from H.M. Stationery Office, price Pound 1.00.

PERCON is a computer code which evaluates temperatures in three dimensions for a block containing heat sources and having coolant flow in one dimension. The solution is obtained at successive planes perpendicular to the coolant flow and the progression from one plane to the next occurs by the heat to the coolant determining convective boundary conditions at the next plane after due allowance being made for any lateral mixing or mass transfer between coolants. It is also possible to calculate the diametral change along a radius as a function of irradiation shrinkage and thermal expansion. This is used in a through-life calculation which evaluates interaction pressure in tubular fuel elements. Physical property data used by the code may be specified as functions of temperature. The coolant flow may be specified, or alternatively derived by the program to satisfy either a specified overall pressure drop or mixed mean temperature rise. The pressure drop through each coolant is calculated and the flow modified, followed by a repeat of the temperature calculation, until the pressure imbalance between chosen flow channels at chosen axial positions is less than the specified convergence limit. A detailed description of the facilities in the code is given and some cases which have been studied are discussed.

3047 A fuel rod for nuclear reactors and a device for sealing said rod. Duncan, R.; Barna, R.P. (to Westinghouse Electric Corp., Pittsburgh, Pa. (USA)). French Patent 2245055/A/. 18 Sep 1974. 10p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France); priority claim: 20 Sep 1973, USA.

A fuel rod for nuclear reactors, and a device for injecting pressurized gas into said rod and simultaneously sealing it are described. The rod has an end-plug provided with a radial opening on the path of the circular weld connecting the plug to the rod-ends, said weld also obturating said pressurizing opening so that the fuel rod remains filled with pressurized gas at the moment of the welding operation in the pressure-chamber. By means of such an arrangement, the fuel rod can be both obturated and pressurized in one step.

3048 Method of checking finished nuclear reactor fuel rods. Wahode, P.; Steinberg, E.; Cheliotis, G. (to Siemens A.G., Berlin (F.R. Germany); Siemens A.G., Muenchen (F.R. Germany). Lab.). German(FRG) Patent 2341678/A/. 27 Feb 1975. 7p. (In German).

2 figs.

The method described is to determine the clearance between the wall of a thin-walled cladding tube and the nuclear fuel filling in finished nuclear reactor fuel rods. In order to prevent the arising of cladding wrinkling through the coolant pressure in operation, fuel elements with too much clearance are separated out. The process involves a capacitive method where ring electrodes separated by an insulating layer are arranged around the cladding tube on one or several positions of the cladding tube. The cladding tube itself forms the counter electrode. By admission of a pressure medium, e.g. He with a pressure of 250 bar, into a pressure pipe in which the cladding tube is enclosed, the diameter of the cladding tube is reduced corresponding to the clearance. Thus a capacity change of the condenser is caused, formed by the ring electrode and counter electrode which is recorded with known measuring equipment.

3049 Nuclear fuel particle and method of production. Wagner-Loffler, M. (to Commission of the European Communities, Luxembourg). German(FRG) Patent 2445760/A/. 10 Apr 1975. 13p. (In German).

2 figs.

The core consisting of fuel oxide (UO_2 or Th or Pu oxide) of a fuel particle coated with carbon-contained material is enriched with a small addition (max 6 wt.%) of a Ba or Sr compound (atomic ratio for nuclear fuel oxide Ba being 5 - 10 : 1) which is to prevent fission products breaking the protective carbon and/or silicon carbide coating; the Ba or Sr molybdate generated is to reduce the pressure of the carbon dioxide produced. Methods to manufacture such nuclear fuel particles are proposed where 1) an agglomerization and shaping of the spheres in a fast cycling bowl and 2) a formation of drops from a colloidal solution which are made to congeal in a liquid paraffin column, take place followed by the pyrolytic coating of the particles.

3050 Improvements in or relating to nuclear reactor fuel element assemblies. Chetter, J. (to UKAEA). Australian Patent 463432/B/. 9 Jul 1975. 25p.

Filed 3 Jul 1972, publ. 10 Jan 1974, priority GB 7 Jul 1971 (71/32003), copies available from the Commissioner of Patents, Canberra.

A description is given of a spacer grid comprising a substantially rigid grid structure formed from intersecting strip members defining cells which are penetrated by fuel pins bearing against rigid stops projecting inside the cells and spring locating members in the form of bow springs which extend longitudinally in the cells of the grid structure to hold the fuel pins against the rigid stops in the cells. The bow spring members of each line of cells extending in one direction across the grid structure have their corresponding ends interconnected by common longitudinal bridging strips to form a ladder spring assembly.

3051 Critical heat transfer points in the fuel rods of power reactors. Subbotin, V.I.; Alekseev, G.V.; Peskov, O.L.; Sapankevic, A.P. *Arch. Energiewirtsch.*; **29**: No. 11, 1094-1105(Nov 1975). (In German).

6 figs.; 1 tab.; 13 refs. Short communication only. Translated from Russian. Also published in Teploehnergetika v. 21(9) p. 24-29.

3052 Development of a coating plant operated by remote control for the refabrication of HTR fuel elements. Baier, J.; Damm, W.; Grahmann, U.; Warzawa, W. (Hochtemperatur-Reaktor-Brennelement G.m.b.H. (HOBEG), Hanau (F.R. Germany); Nuklear-Chemie und -Metallurgie G.m.b.H. (NUKEM), Hanau (F.R. Germany)). pp 431-434 of In Reactor conference, Duesseldorf, 30.3.-2.4.1976. Section 2: Fuel elements, fuel cycle and isotope technique. Eggenstein-Leopoldshafen, F.R. Germany; ZAED (1976). (In German)

From Reactor meeting; Duesseldorf, F.R. Germany (30 Mar 1976).

1 fig.; 1 ref. Short communication only.

3053 Calculation of the temperature fields in microfuel elements for nuclear reactors. Kolos, V.P.; Khorev, V.I.; Pobedrya, A.E. (Inst. of Nuclear Power Engineering, Minsk). *Vestsi Akad. Navuk BSSR, Ser. Fiz.-Energ. Navuk;* No. 1, 12-19(1976). (In Russian).

The problem of the stationary heat transfer in a spherical body with the inner source of heat is considered. The solution of the problem permits calculation of the temperature field in a reactor core with spherical fuel elements. Heating of a coolant is taken into account in the calculation. The rule of the change of the coefficient of heat transfer on the surface of spherical heat exchange elements is assumed to be known.

3054 Effect of porosity correction models on maximum fuel temperatures. Peddicord, K.L.; Cox, K.J.; Henderson, J.M.; Lucas, K.A. (Oregon State Univ., Corvallis, OR). *Trans. Am. Nucl. Soc.*; **23**: 440-441(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

CONTROL SYSTEMS

REFER ALSO TO CITATION(S) 3095

3055 (AEEW-M—1378) **Principles of nuclear power station control.** Knowles, J.B. (UKAEA Reactor Group, Winfrith. Atomic Energy Establishment). Dec 1975. 30p. INIS.

This memorandum represents lecture notes first distributed as part of a UKAEA introductory course on Reactor Technology held during November 1975. A nuclear power station is only one element of a dispersed interconnected arrangement of other nuclear and fossil-fired units which together constitute the national 'grid'. Thus the control of any one station must relate to the objectives of the grid network as a whole. A precise control of the supply frequency of the grid is achieved by regulating the output power of individual stations, and it is necessary for each station to be stable when operating in isolation with a variable load. As regards individual stations, several special control problems concerned with individual plant items are discussed, such as: controlled reactivity insertions, temperature reactivity time constants and flow instability. A simplified analysis establishes a fundamental relationship between the stored thermal energy of a boiler unit (a function of mechanical construction) and the flexibility of the heat source (nuclear or fossil-fired) if the station is to cope satisfactorily with demands arising from unscheduled losses of other generating sets or transmission capacity. Two basic control schemes for power station operation are described known as 'coupled' and 'decoupled control'. Each of the control modes has its own merits, which depend on the proposed stationoperating strategy (base load or load following) and the nature of the heat source.

3056 (NEDO—21021) **Test program for collet retainer tube.** (General Electric Co., San Jose, Calif. (USA). BWR Projects Dept.). Mar 1976. 33p. General Electric Co., San Jose, CA.

During a routine maintenance outage at a General Electric Boiling Water Reactor (BWR) cracking was discovered on the collet retainer tubes (CRT) of control rod drives. Upon the discovery of this cracking, an inspection program to examine accessible CRT's with in-reactor operating histories was initiated. The results of the test program which was instituted to determine the functional margin of cracked CRT's are summarized.

3057 (RLO—2225-T34-5) **Sodium boiling detection in LMFBRs (Phase I). 5th quarterly technical progress report, July 1, 1975—October 31, 1975.** Albrecht, R.W.; McCormick, N.J. (Washington Univ., Seattle (USA)). 1975. Contract AT(45-1)-2225. 6p. Dep. NTIS $3.50.

Progress summarized includes the design of a gamma heated subassembly for sodium boiling experiments and an experiment showing that neutronic noise and acoustic noise caused by sodium boiling are highly correlated in a wide frequency band about the bubble repetition frequency. (DG)

3058 (RLO—2225-T34-6) **Sodium boiling detection in LMFBRs (Phase I). 6th quarterly technical progress report, November 1, 1975—December 31, 1975.** Albrecht, R.W.; McCormick, N.J. (Washington Univ., Seattle (USA)). 1975. Contract AT(45-1)-2225. 4p. Dep. NTIS $3.50.

Progress summarized includes the design of a gamma heated subassembly for sodium boiling experiments. (DG)

3059 (TRG-REPORT—2716(D)) **A control rod interaction model developed to meet the operational requirements of the PFR.** Wheeler, R.C.; Tait, D.; Webster, E.B. (UKAEA Reactor Group, Risley). Aug 1975. 44p. INIS.

Available from H.M. Stationery Office, price Pound 1.50.

Control rod worths in the Prototype Fast Reactor (PFR) are strongly affected by the positions of other rods. Routine reactivity estimations, accountancy and rod calibrations are much aided by a control rod interaction model which was developed during the first few months of commissioning. The model described is fitted to experimental results. It does not compete in precision with neutron diffusion theory results, but provides rapid answers of sufficient accuracy for most operational and routine safety requirements. Using the model for quidance, future recalibrations of the PFR rods should be accomplished with increased understanding and with less on-line time.

3060 Simulation and control of the site-dependent neutron density in a nuclear reactor. Stark, K. Stuttgart; Stuttgart Univ. (18 Feb 1974). 104p. INIS.(In German).

42 figs.; 28 refs. Available from the library of the Stuttgart Univ.

Thesis (Ph. D.).

The present work deals with the simulation and control of a pressurized-water reactor such as is used in nuclear power plants today. In the first part of the work, the mathematical model equations of the reactor are set up. They take into consideration the local distribution of the various reactor parameters as far as seems necessary for further investigations. Taking the given approximations, the mathematical model is locally one-dimensional; it is valid for the period of time in which a power control of the reactor must work. The model equations set up are calculated on an analog/hybrid computer according to the modal simulation method in true time. The method is distinguished in the present problem here through good convergence and enables the observation of the simulation results as a stationary picture on an oscillograph screen. For this reason, a simulation of this type seems particularly suitable for the training of operational personnel. The aim of the second part of the work is the development of a simple control concept which enables the control of the total power of the reactor as well as of the distribution of the power density in the reactor core. The fundamentals of the control design are the non-linear system equations of the nuclear reactor. The developed control is based on the controlling of eigenfunctions; it controls the total power of the reactor as well asthe distribution of the power density in the reactor core where a uniform burn-up of the nuclear fuel is seen to. Part-absorbing control rods among others are used as actuators like they are already used in that type of reactors.

3061 Apparatus for measuring the overall volume of inclusions in a substance by means of ultrasonic waves. (to UKAEA). French Patent 2244172/A/. 16 Sep 1974. 7p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France); priority claim: 17 Sep 1973, UK.

The invention relates to an ultrasonic test apparatus of the type comprising a device for irradiating a substance with ultrasonic pulses and a device for sensing the echoes sent back by the inclusions contained in said substance, comprising a device for determining the overall power contained in the reflected pulses. This can be applied to determining the total volume of gas driven by a liquid.

3062 On-load surveillance of nuclear power plant components by noise and vibration analysis. Bohnstedt, H.J. (Allianz-Zentrum fuer Technik G.m.b.H. (AZT), Ismaning/Muenchen (F.R. Germany). Fachgruppe Maschinendynamik). *Maschinenschaden;* **48**: No. 3, 95-96(1975). (In German).

2 figs.; 6 refs.

The report published by the European Atomic Energy Commission reviews the experience gathered on on-load surveillance techniques based on noise and vibration analysis with respect to nuclear power plant components, light-water reactors, and steam turbines. The theoretical principles are discussed, the measuring devices described and the applied surveillance techniques elucidaded. A summary is then given of the test results obtained by the various organisations involved in the preparation of the report. A comparative analysis of the test results is presented.

3063 The use of acoustic emission for monitoring the integrity of steel pressure vessels. Holt, J.; Palmer, I.G. (Central Electricity Research Labs., Leatherhead (UK)). pp 46-51 of In Periodic inspection of pressurized components. A conference arranged by the Applied Mechanics Group and the Nuclear Energy Group of the Institution of Mechanical Engineers, London, 4-6 June 1974. London; Mechanical Engineering Pub. for Institution of Mechanical Engineers (1975).

From Conference on periodic inspection of pressurized components; London, UK (4 Jun 1974).

The present status of the application of acoustic emission to the location and assessment of defects in steel pressure vessels is reviewed. Particular attention is given to the results and implications of a materials evaluation program on reactor pressure vessel steel. The further laboratory and model pressure vessel tests required to fully develop and establish the results of this program are discussed.

3064 Nuclear electronic equipment for control and monitoring boards. MCH/MENT Recommendations. Roquefort, H. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Services d'Electronique). *Onde Electr.;* **55**: No. 8, 440-442(Oct 1975). (In French).

From One-day meeting on electronic instrumentation for nuclear reactor control; Paris, France (18 Dec 1974).

The constitution of the group "Materiel de Controle Homologue - Materiel Electronique Nucleaire pour Tableaux de controle et de commande" is given. This group has to define, work out, and propose general and particular specifications related to reactor control-board instrumentation. These specifications are useful in France and abroad. Published documents are listed.

3065 Industrial development of neutron detectors, fission chambers, self powered detectors, ionization chambers. Constans, H. (La Radiotechnique Compelec (RTC), 92 - Suresnes (France)); Coville, P. (Societe Anonyme d'Etudes et Realisations Nucleaires (SODERN), 94 - Limeil-Brevannes (France)); Guerre, J. (Etablissements Merlin et Gerin, 38 - Grenoble (France)). *Onde Electr.;* **55**: No. 8, 449-456(Oct 1975). (In French).

From One-day meeting on electronic instrumentation for nuclear reactor control; Paris, France (18 Dec 1974).

Reactor control requires the determination of neutron flux at all times. The needed characteristics lead to use of several types of detectors: boron lined counters, boron lined ionization chambers, fission ionization chambers and self powered detectors. The principle of the reaction involved, the fabrication requirements, the different modes of utilization, and the characteristics obtained are examined for each detector. The problem of electric connections in the active area has been solved by developing integrated cables.

3066 Time-optimal control of WWR-SM type reactor. Kubowski, J. (Institute of Nuclear Research, Swierk (Poland). Reactor Physics Dept.). *Atomkernenergie;* **27**: No. 1, 35-38(1976).

6 figs.; 1 tab.; 5 refs.

Time-optimal control was considered only with regard to xenon poisoning of WWR—SM type reactor. The point-kinetic model based on two energy groups was applied to calculate the xenon reactivity effects. The influence of the optimal control on the built-in reactivity is shown. The computational technique was developed for direct determination of both power and reactivity vs. real time. To check the applicability of the calculational method the experiment was performed and the results indicate that the precalculated optimal trajectory agree within an accuracy sufficient for practical application.

3067 New boron control law for load-following PWRs. Perdikis, G.C. (Commomwealh Edison Co., Zion, IL); Bailey, R.E. *Trans. Am. Nucl. Soc.;* **23**: 427-428(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3068 Reactor temperature control instrumentation for the Clinch River Breeder Reactor Plant. DeMore, L.A.; Gillett, J.E.; Matta, J.V. (Westinghouse Electric Corp., Madison, PA). *Trans. Am. Nucl. Soc.;* **23**: 430-431(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3069 New monitoring method for BWR plant equipment. Kato, K. (Hitachi, Ltd., Kanagawa, Japan); Murata, F.; Sumida, I.; Doi, A.; Kiki, Y. *Trans. Am. Nucl. Soc.;* **23**: 468-469(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 2493, 3150, 3152, 3486, 3818

3070 (ORNL—5097) Assessment of water resources for nuclear energy centers. Samuels, G. (Oak Ridge National Lab., Tenn. (USA)). Sep 1976. Contract W-7405-eng-26. 105p. Dep. NTIS $5.50.

Maps of the conterminous United States showing the rivers with sufficient flow to be of interest as potential sites for nuclear

energy centers are presented. These maps show the rivers with (1) mean annual flows greater than 3000 cfs, with the flow rates identified for ranges of 3000 to 6000, 6000 to 12,000, 12,000 to 24,000, and greater than 24,000 cfs; (2) monthly, 20-year low flows greater than 1500 cfs, with the flow rates identified for ranges of 1500 to 3000, 3000 to 6000, 6000 to 12,000, and greater than 12,000 cfs; and (3) annual, 20-year low flows greater than 1500 cfs, with the flow rates identified for ranges of 1500 to 3000, 3000 to 6000, 6000 to 12,000, and greater than 12,000 cfs. Criteria relating river flow rates required for various size generating stations both for sites located on reservoirs and for sites without local storage of cooling water are discussed. These criteria are used in conjunction with plant water consumption rates (based on both instantaneous peak and annual average usage rates) to estimate the installed generating capacity that may be located at one site or within a river basin. Projections of future power capacity requirements, future demand for water (both withdrawals and consumption), and regions of expected water shortages are also presented. Regional maps of water availability, based on annual, 20-year low flows, are also shown. The feasibility of locating large energy centers in these regions is discussed.

3071 (ORNL/NUREG/TM—22) **Post licensing case study of community effects at two operating nuclear power plants. Final report, March 1975—March 1976.** Purdy, B.J.; Peelle, E.; Bjornstad, D.J.; Mattingly, T.J. Jr.; Soderstrom, J.; DeVault, R.C. (Oak Ridge National Lab., Tenn. (USA)). Jun 1976. Contract W-7405-Eng-26. 127p. Dep. NTIS $6.00.

The social, economic, and political/institutional impacts of two operating nuclear power complexes on two New England communities are studied. The report includes discussions of the study design and objectives, profiles of the towns of Plymouth, Massachusetts, and Waterford, Connecticut, and analysis of the social, economic, and political impacts as observed by members of the ORNL staff. Results are presented from an attitude survey as well as a social impact classification schema devised as a methodological tool.

3072 Environmental impact of integrated nuclear-hydrogen electrical generation parks. Shepherd, S.H.; Ringle, J.C. (Oregon State Univ., Corvallis). *Trans. Am. Nucl. Soc.*; **23**: 454-455(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

SITING

REFER ALSO TO CITATION(S) 3163

3073 (COO—2394-1) **Forecasting power plant effects on the coastal zone. EG and G final report number B-4441.** (EG and G, Inc., Waltham, Mass. (USA)). Jun 1976. Contract E(11-1)-2394. 557p. Dep. NTIS $13.00.

Field methods, data analyses, and calculation are presented exemplifying procedures for oceanic dispersion prediction as a tool for forecasting power plant effects on the coastal zone. Measurements were made of dye, drogues and temperatures near Pilgrim Station's discharge (Plymouth, Massachusetts), and of currents and other variables across Massachusetts Bay. Analysis of current data illustrates separation of tidal, wind-driven and inertial constituents and their significance for dispersion. Dye and temperature dispersion are compared with the currents study, and diffusion coefficients estimated. Current data from coastal sites (New Jersey and Massachusetts) are analyzed to determine field requirements for dispersion estimates. Methods to calculate expected precision of estimates based on brief current records are developed. Model calculations predicting dispersion based on observed ocean currents are described. Formulae are derived to estimate the spatial distribution of impact from a discharge. A numerical model to calculate discharge dispersion in more detail is discussed and used to study time variations of discharge effects. Model predictions are compared with field observations.

3074 Meteorological information system for nuclear power plants. Dilger, H.; Huebschmann, W.; Thomas, P. (Kernforschungszentrum Karlsruhe (F.R. Germany). Abt. Strahlenschutz und Sicherheit). *KFK Nachr.*; **7**: No. 3, 66-69(1975). (In German).

8 figs.; 1 tab.; 6 refs.

At Karlsruhe Nuclear Research Centre, a meteorological information system has been in existence for several years. The experience gained on the reliability and availability of various methods of measurement is used as a basis for the simplified system proposed here which provides the necessary meteorological information for the site of a nuclear power station in a reliable and efficient way.

3075 Environment and ecology in the design and construction of a nuclear power station. Lebreton, J.C. (Electricite de France, 75 - Paris. Dept. Etudes Generales Programmes-Sites Environnement). *Rev. Fr. Electr.*; **48**: No. 249, 27-31(1975). (In French).

The purpose of the studies on the environment of nuclear stations is to reduce changes to the surroundings as much as possible in order not to interfere with ecosystems and consequently impede human activities. A nuclear power station implies heat discharges, radioactive effluent, and wastes and produces a certain sound level and creates aesthetic problems of space occupation. The main questions dealt with are those of heat discharge and noise, together with architectural and aesthetic problems. In the first two cases the intention is to define as accurately as possible the levels reached by the temperature or noise parameter. Where noise is concerned it is enough to know these levels in order to define an eventual hindrance to the target in question, the human being in this case. For heat fluxes man is not directly involved and further research is planned to identify the sensitivity of plants and animals. Since the environment also covers aesthetics, an effort is made to safeguard and improve the quality of the landscape.

3076 Power generation - siting and environment. Marnet, C. (Stadtwerke Duesseldorf (F.R. Germany)). pp 50-53 of In The electricity industry in the Federal Republic of Germany. Eymueller, T.; Uebbing, H.; Boecker, H. (comps.). Frankfurt am Main, F.R. Germany; Institut fuer Bilanzanalysen (1975). (In German)

29 refs.

A brief survey is given on site selection, environmental effects (emission of dust, gases, heat, radioactivity), and on the problems arising from plant construction which today involves building times of between 5 and 10 years for conventional and nuclear power plants.

3077 Selection and securing of nuclear power plant sites in Baden-Wuerttemberg. Grawe, J. *Energiewirtsch. Tagesfragen;* **25**: No. 1;2, 31-34(1975). (In German).

The methods used and the results obtained by the interministerial study group 'Nuclear Power Plant Sites' in Baden-Wuerttemberg are presented and the function, contents, and legal consequences of a technical development concept 'Nuclear Power Plant Sites', its establishment, and the next steps under consideration are described.

3078 Sites and safety of nuclear plants. Doury, A. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. de Surete Nucleaire). *Bull. Inf. Sci. Tech. (Paris);* No. 208, 11-18(Nov 1975). (In French).

The problems raised by nuclear plant safety in relation to sites and environment are briefly reviewed, care being taken to avoid all unnecessary technical details and explain as clearly as possible the general methods and procedure currently enforced and the nature, quality, and magnitude of the means employed. Following an outline of the basic research necessary a paragraph is devoted specially to the "site" chapter of safety reports, which presents the results of the study made by the owner-operator.

3079 Risk-cost analysis of remote nuclear siting. Niehaus, F.; Cohen, J.J.; Otway, H.J. (International Atomic Energy Agency, Vienna). *Trans. Am. Nucl. Soc.*; **23**: 451-452(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

RADIOACTIVE EFFLUENTS

REFER ALSO TO CITATION(S) 2557

3080 (Juel—1220) **Future radioactive environmental pollution in the Federal Republic of Germany by radionuclides from nuclear facilities in normal operation. 1st report.** Bonka, H.; Schulten, R.; Bruessermann, K.; Schwarz, G.; Bieselt, R.; Winske, P.; Brenk, D.; Vogt, K.J.; Darvas, J.; Laser, M. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorentwicklung; Technische Hochschule Aachen (Germany, F.R.). Lehrstuhl fuer Reaktortechnik). Jul 1975. 234p. (In German). INIS.

With figs., tabs. and refs.

Based on important gaseous and liquid radioactive effluents, mainly T, ^{85}Kr, ^{129}I, ^{131}I, and ^{133}Xe, from modern nuclear power plants and corresponding reprocessing plants and on a prediction of the nuclear power plant capacity expansion over a period of approximately 100 years, future radiation exposure is examined. Local and regional radiation exposure due to waste air as well as the potential radiation exposure due to liquid effluent in running waters and their use for drinking water are studied. The global effects are dealt with. The results are compared with the variation of the natural radiation exposure of the population in the FRG. There

is evidence that the future additional radiation dose will be within the limits of the fluctuation of the natural radiation exposure if it is possible to retain the nuclides T and ^{85}Kr at a rate of about 90% to 99% and iodine at a rate of about 99% to 99.8% in the first large reprocessing plants.

3081 (KFK—2153) **Production and release of Sr-89, Sr-90, Ru-103, Ru-106, Cs-134, Cs-135, Cs-137, Ce-141, and Ce-144 by nuclear power plants and reprocessing plants and the expected radiological burden until the year 2000.** Schiesser, D. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Neutronenphysik und Reaktortechnik; Kernforschungszentrum Karlsruhe (Germany, F.R.). Projekt Nukleare Sicherheit; Karlsruhe Univ. (TH) (Germany, F.R.). Fakultaet fuer Maschinenbau). Aug 1975. 167p. (In German). INIS.

Thesis. 260 refs.; with figs. and tabs.

The natural production of long-lived radioisotopes of the elements strontium, ruthenium, and cerium is summarized together with the yields from nuclear weapons tests and nuclear facilities. Specific production rates and the consequent release rates are evaluated for the different types of nuclear power plants (1,000 MWe). Estimated release rates from fuel reprocessing plants are also included, based on presently attainable decontamination factors. Local radiological burdens are specified resulting from the releases of radionuclides by nuclear power plants and reprocessing plants. Based on the forecasted onset of nuclear facilities, the global accumulated activity of single-nuclided releases of these facilities until the year 2000 is calculated.

3082 **Environmental impact due to nuclear power plants. An attempt to determine the risk factor.** Kellermann, O. (Institut fuer Reaktorsicherheit der Technischen Ueberwachungs-Vereine e.V., Koeln (F.R. Germany)); Balfanz, H.P. (Institut fuer Reaktorsicherheit der Technischen Ueberwachungs-Vereine e.V., Koeln (F.R. Germany). Abt. Auslegung). *Tech. Ueberwach.*; **16**: No. 12, 364-368(Dec 1975). (In German).

1 fig.; 6 tabs.; 8 refs.

The environmental impact due to nuclear power plants is smaller than that due to fossil-fired power plants. The risks of the nuclear power plant operation are determined by the quantity and the probability of the release of radioactive materials. According to the value, the risks of normal operation can be compared to the accident risks. An attempt should be made to effectively reduce the remaining risk at unfavourable sites with the emphasis on accidents with larger effects than design basis accidents.

3083 **Issue of plutonium toxicity.** Cohen, B.L. (Univ. of Pittsburgh). *Trans. Am. Nucl. Soc.*; **23**: 442(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3084 **Determination of design bases noble-gas source term and release trends from BWRs in the United States.** Phillips, J.W.; Gaul, G.A.; Barrick, M.K. (Environmental Protection Agency, Washington, DC). *Trans. Am. Nucl. Soc.*; **23**: 469(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

THERMAL EFFLUENTS

3085 **Echauffements des eaux par les centrales nucleaires. Note no.4. Facade Atlantique. Cas particulier de la Gironde. (Heating of water by nuclear power stations. Note number 4. Atlantic coast. Special case of the Gironde).** Paris; Electricite de France (14 Jan 1975). 9p. (In French).

Distributed by Centre de Documentation Nucleaire, EDF - Direction de l'Equipement, 29 avenue de Messine, 75008 Paris.

Heat transfer in the sea depends closely on local conditions, i.e. on the morphology of the coastline. Each case must therefore be examined individually from both the physical and the biological aspect. Three morphologically and ecologically different zones are dealt with separately: the South coast of Britanny and the Vendean coast as far as the Breton Straits; the coast along the Aunis and Saintonge for the Poitou Marsh as far as the Maumusson Straits; the Landes coast, the Coubre region and the West coast of the Isle of Oleron. The case of estuaries is rather special and should be dealt with apart. The special case of the Gironde is discussed.

3086 **Nuclear power plants and thermal pollution of the environment.** Burkhard, G.A.; Basler, H. *Brown Boveri Rev.*; **63**: No. 1, 22-33(Jan 1976).

The article compares the thermal pollution of the environment by nuclear plants with that of other power plants. Based on the fundamental laws of thermodynamics and the thermal pollution caused by the various methods of power generation, means of utilizing the waste heat from the plants for district heating are described with reference to examples. It is found that, for Switzerland in particular, the utilization of the heat from nuclear power plants could considerably reduce the consumption of fuel oil. However, since it is not always possible to utilize all the heat produced, especially in summer, it has to be dissipated by some other means. To avoid heating the rivers up excessively, cooling towers may be used. A brief summary of the present technical standard of cooling towers and their effects on the surroundings is followed by theories connecting the possible influence on the climate of heat and dust caused by burning fossil fuels with the climate. In order to reduce pollution, future development will have to be largely away from fossil fuels and more towards nuclear plants combined with district heating. Naturally the availability of the primary sources of energy plays a very important part.

3087 **Thermal impact assessment of large power plants in coastal regions.** Eraslan, A.H. (Univ. of Tennessee, Knoxville); Barton, J.M.; Diament, H.; Sharp, R.D.; Bauman, H.F.; Robertson, R.C. *Trans. Am. Nucl. Soc.*; **23**: 455-456(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

RESEARCH, TEST, EXPERIMENTAL, ZERO-POWER, AND TRAINING REACTORS AND SUBCRITICAL ASSEMBLIES

REFER ALSO TO CITATION(S) 2911, 3066, 3130, 3147, 3766

3088 (GA-A—12710) **General Atomic participation in the High Temperature Lattice Test Reactor program.** Schultz, K.R.; Mathews, D.R. (General Atomic Co., San Diego, Calif. (USA)). Mar 1976. Contract E(04-3)-167. 108p. Dep. NTIS $5.50.

The five experiments of the High Temperature Lattice Test Reactor (HTLTR) program were carried out at Battelle Northwest Laboratories as part of the USAEC General Reactor Technology Program. The object of the experiments was to measure zero power reactor lattice parameters, specifically k/sub infinity/, in HTGR type lattices at temperatures ranging from room temperature to 1000°C. This report summarizes the analysis of these experiments that was performed at General Atomic Company. This analysis was initially intended to be merely an independent analytical determination of the lattice parameters but was expanded to include investigations into the theory of the experiment, reanalysis of some of the experimental data and results, and careful scrutiny of the methods and data used in both experiment and calculation.

3089 (HEDL-FCD—188) **FFTF head temperature distributions.** (Hanford Engineering Development Lab., Richland, Wash. (USA)). Dec 1975. Contract E(45-1)-2170. vp. AT.

The FFTF Closure Head has been analyzed for operations in both the steady and transient states in order to aid in defining the adequacy of the Head and Center Island Heating and Cooling Systems. The analyses were performed using nodal models (in three dimensions) of the Head and Shield Plates, and of the Center Island region of the Head and Shield Plates. These models and the associated techniques used in the analyses are discussed in detail. The results, in the form of temperature distributions, are discussed. It has been found, in general, that most events the Head may experience result in reduced gradients throughout the Head. In those few instances wherein temperatures and gradients increase significantly, it was found that the severity of the event may be limited by shutting the reactor down.

3090 (HEDL-SA—75-48) **Evaluation of FFTF fuel pin design procedure vis-a-vis steady state irradiation performance in EBR II.** Jackson, R.J. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Nov 1976. Contract E(45-1)-2170. 31p. Dep. NTIS $5.00.

The FFTF fuel pin design analysis is shown to be conservative through comparison with pin irradiation experience in EBR-II. This comparison shows that the actual lifetimes of EBR-II fuel pins are either greater than 80,000 MWd/MTM or greater than the calculated allowable lifetimes based on thermal creep strain.

3091 (HEDL-SA—987) **Evaluation of the ability of rod drop tests to verify the stability margins in FTR.** Harris, R.A.; Sevenich, R.A. (Hanford Engineering Development Lab., Richland, Wash. (USA)). 1976. Contract AT(45-1)-2170. 32p. (CONF-751101—79). Dep. NTIS $4.00.

From Joint meeting of the American Nuclear Society and the Atomic Industrial Forum; San Francisco, California, USA (16 Nov 1975).

Predictions of the stability characteristics of FTR indicate that the reactor can be easily controlled even under the worst possible conditions. Nevertheless, experimental verification and monitoring of these characteristics will be performed during operation of the reactor. An initial evaluation of rod drop experiments which could possibly provide this verification is presented.

3092 (Juel—1197) **Measurement of fission gases released by HTR irradiation samples in the BR 2 reactor (Mol/Belgium).** Koetter, H.; Mueller, H.B. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Zentralabteilung Brennelement- und Bestrahlungstechnologie). Apr 1975. 14p. (In German). INIS.

9 figs.; 2 tabs.; 5 refs.

During the irradiation of HTR-test fuel (coated particles resp. compacts) the release rate of fission gases is measured automatically. For that purpose the γ-spectrum of the sweep gas is analyzed with respect to the isotopes Xe-133, Xe-135, Xe-135sup(m), Xe-137, Xe-138, Kr-85sup(m), Kr-87, Kr-88, Kr-89. Gas sampling, spectral analysis, data handling and evaluation are controlled by computer.

3093 Experimental facilities of Valduc critical station. Mangin, D. (CEA Centre d'Etudes de Valduc, 21 - Is-sur-Tille (France)); Maubert, L. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service d'Etudes de Criticite). *Bull. Inf. Sci. Tech. (Paris);* No. 208, 69-76(Nov 1975). (In French).

The critical facility of Valduc and its experimentation possibilities are described. The different experimental programs carried out since 1962 are briefly reviewed. The last program involving a plutonium nitrate solution (18.9wt%^{240}Pu) in a large parallelepipedic tank is presented and main results given.

3094 Inverse kinetics determination of reactivity at PURNIMA zero energy fast reactor. Das, S.; Srinivasan, M. (Bhabha Atomic Research Centre, Bombay (India). Neutron Physics Section). *Atomkernenergie;* **27**: No. 1, 18-22(1976).

8 figs.; 1 tab.; 19 refs.

An inverse kinetics algorithm applicable to the plutonium-fuelled zero-energy fast reactor PURNIMA has been developed for the interpretation of kinetic experiments. By introducing reactivity perturbation of various kinds and analysing the resultant neutronic behaviour, the worths of various reactivity manipulation mechanisms of PURNIMA reactor have been determined. The technique has proven to be a reliable method for determining the inherent neutron source strength in the reactor.

3095 Digital control of a nuclear research reactor at low-power levels. Gray, J.O.; De Melo, A.F.P. (Manchester Univ. (UK)). *Proc. Inst. Electr. Eng. (London);* **123**: No. 3, 261-266(Mar 1976).

A computer control loop has been implemented for the regulation of the Universities' Research Reactor at very-low-power levels where the reactor-signal dynamics can be represented by staionary stochastic distributions. Optimum mean-square-error compensators were derived using a numerical method and implemented on a PDP8E computer which controlled a high-speed stepping motor assembly in the reactor core.

3096 SR-OB exponential assembly. Simane, C.; Matejka, K. (Ceske Vysoke Uceni Technicke, Prague (Czechoslovakia). Fakulta Jaderna a Fysikalne Inzenyrska); Fleischhans, J.; Jilek, M. (Skoda, Plzen (Czechoslovakia). Zavod Vystavba Jadernych Elektraren). *Jad. Energ.;* **22**: No. 4, 128-132(Apr 1976). (In Czech).

The exponential assembly SR-OB for experimental research and pedagogical work on exponential lattices of enriched uranium rods moderated by heavy water was built at the Faculty of Nuclear Science and Physical Engineering, Prague. The construction, the basic physical characteristics, and the first operating experience are described.

3097 Use of the annular core pulse reactor (ACPR) for fast reactor safety research. Coats, R.L. (Sandia Labs., Albuquerque, NM); Schmidt, T.R.; Wright, R.W. *Trans. Am. Nucl. Soc.;* **23**: 328-329(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3098 Design and safety evaluation of radioactive gas handling and storage in the FFTF. Armstrong, G.R.; Hale, J.P.; Halverson, T.G. (Hanford Engineering Development Lab., Richland, WA). *Trans. Am. Nucl. Soc.;* **23**: 391-393(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3099 FFTF reload core nuclear design for increased experimental capability. Rothrock, R.B.; Nelson, J.V.; Dobbin, K.D.; Bennett, R.A. (Hanford Engineering Development Lab., Richland, WA). *Trans. Am. Nucl. Soc.;* **23**: 445-446(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3100 Design of Sandia Pulsed Reactor III (SPR III). Reuscher, J.A.; Schmidt, T.R.; Coats, R.L.; Sasmor, D.J.; Cox, D.N. (Sandia Labs., Albuquerque, NM). *Trans. Am. Nucl. Soc.;* **23**: 476(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3101 Performance characteristics of the Sandia Pulsed Reactor III. Reuscher, J.A.; Estes, B.F.; Philbin, J.S. (Sandia Labs., Albuquerque, NM). *Trans. Am. Nucl. Soc.;* **23**: 476-477(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3102 Visual inservice inspection system for the Fast Flux Test Facility. Clark, R.A. (Kollmorgen Corp., Northampton, MA). *Trans. Am. Nucl. Soc.;* **23**: 477-479(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3103 Radioactivity of water in a swimming pool research reactor. Pasqualetto, H.; Hukai, R.Y. (Instituto de Energia Atomica, Sao Paulo, Brazil). *Trans. Am. Nucl. Soc.;* **23**: 480(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3104 Physics aspects of the ANL Safety Research Experiment Facility (SAREF) design. Travelli, A.; Snelgrove, J.L.; Matos, J.; Klotzkin, G.; Odom, J.P.; Lam, S.K.; Kier, P.H.; Lewis, R.A. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* **23**: 554-556(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3105 Nuclear characteristics of a Class III fast spectrum Safety Research Facility (SAREF) design. Bailey, H.S.; Harless, W.H. (General Electric Co., Sunnyvale, CA). *Trans. Am. Nucl. Soc.;* **23**: 556-558(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3106 Physics aspects of fast reactor safety test facility designs. Palmer, R.G.; McLaughlin, T.P.; Sapir, J. (Los Alamos Scientific Lab., NM). *Trans. Am. Nucl. Soc.;* **23**: 558(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3107 Neutronic analysis for Sandia Pulsed Reactor III (SPR III). Schmidt, T.R.; Coats, R.L. (Sandia Labs, Albuquerque, NM). *Trans. Am. Nucl. Soc.;* **23**: 560-561(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3108 Feasibility study of a thermal-driven fast blanket. Rodrigues, V.G.; Hukai, R.Y. (Instituto de Energia Atomica, Sao Paulo, Brazil). *Trans. Am. Nucl. Soc.;* **23**: 561(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

PLUTONIUM AND ISOTOPE PRODUCTION, CHEMONUCLEAR, MATERIALS TESTING, AND MATERIALS PROCESSING REACTORS

3109 Quality assurance of reactor operation by computer methods. Williams, M.C.; Barlett, R.J. (United Nuclear Industries, Inc., Richland, WA). *Trans. Am. Nucl. Soc.;* **23**: 482-483(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

PROPULSION REACTORS

REFER ALSO TO CITATION(S) 3111, 3180

3110 Operating results of the nuclear ship 'Otto Hahn' in 1974. *Atomwirtsch., Atomtech.*; **20**: No. 11, 581-582(Nov 1975). (In German).

1 fig.; 2 tabs.; 1 ref. Short communication only.

REACTOR SAFETY

3111 (AED-CONF—75-365-020, pp vp.) **Development of a collision protection structure for nuclear powered ships.** Woisin, G. 1975.

From International seminar on extreme load conditions and limit analysis procedures for structural reactor safeguards and containment structures; Berlin, German, Federal Republic of (F.R. Germany) (8 Sep 1975).

11 figs.; 5 tabs.; 10 refs. With abstract. Available from BAM.

In International seminar on extreme load conditions and limit analysis procedures for structural reactor safeguards and containment structures. Suppl. 2.

Recently nuclear container ship studies were carried out with container ships narrow enough to pass the Panama Canal. In this context the collision barrier for the reactor compartment has been changed from an energy-absorbing type (a) to a resisting type (b) structure. An a-type structure mainly consists of decks extending at least 1/5 the ship's width into the ship's sides. The b-type structure consists largely of grillages fitted to the inner part of the outer shell of the ship extending to only 1/12 of the ship's width. The new design was tested with 8 model experiments with the same model testing facility of the GKSS located at the yard of Howaldtwerke-Deutsche Werft AG in Hamburg. The tests were conducted at a scale of 1 : 7.5 and 1 : 12 with 4 different bow models of existing ships. The thickness of the webs of the grillages was varied in order to roughly optimize the thickness. The protective structure was part of a container ship of 80,000 shaft horsepower (NCS 80), the design of which was investigated by the GKSS.

3112 (AED-CONF—75-365-022, pp vp.) **On normal impact of an infinite elastic-plastic thin-walled plate by a finite elastic rod.** Kowalski, S.J.; Kolodziej, J.A.; Raniecki, B. 1975.

From International seminar on extreme load conditions and limit analysis procedures for structural reactor safeguards and containment structures; Berlin, German, Federal Republic of (F.R. Germany) (8 Sep 1975).

10 figs.; 7 refs. With abstract. Available from BAM.

In International seminar on extreme load conditions and limit analysis procedures for structural reactor safeguards and containment structures. Suppl. 2.

The problem of the transverse collision of a finite circular cylinder (flat ended metal projectile) moving with the initial velocity V_o, with an immobile thin infinite plate is considered. According to the experimental evidence, at high speeds (of the order of conventional bullet speeds) the projectile starts penetration of the plate. The plug diameter usually is of about the same diameter as that of the projectile, and white adiabatic shear line cracks parallel to the projectile are observed.

3113 (AED-CONF—75-365-024, pp vp.) **Dynamic rupture analysis of reinforced concrete shells.** Rebora, B.; Zimmermann, T.; Wolf, J.P. 1975.

From International seminar on extreme load conditions and limit analysis procedures for structural reactor safeguards and containment structures; Berlin, German, Federal Republic of (F.R. Germany) (8 Sep 1975).

34 figs.; 2 tabs.; 20 refs.; 2 apps. With abstract. Available from BAM.

In International seminar on extreme load conditions and limit analysis procedures for structural reactor safeguards and containment structures. Suppl. 2.

Extreme dynamic loading conditions often require the rupture analysis of reinforced and prestressed concrete structures. The study presented in this paper extends a method of analysis, which has proven efficient for short and long-time loads, of dynamic loading conditions. Another aim is to adapt the method to thin-walled structures. It is not sufficient to work only with plastic rupture and yield surfaces locally which are compared to the elastic distribution of the stress resultants. It is essential to account for the redistribution of the latter. The method proposed consists of discretizing the structure into isoparametric three-dimensional elements with 20 nodes for the concrete and one-dimensional bar elements with 3 nodes for the steel.

3114 (AED-CONF—75-365-027, pp vp.) **Differential pressures on building walls during tornados.** Yeh, G.C.K. 1975.

From International seminar on extreme load conditions and limit analysis procedures for structural reactor safeguards and containment structures; Berlin, German, Federal Republic of (F.R. Germany) (8 Sep 1975).

10 figs.; 2 tabs.; 7 refs.; 2 apps. With abstract. Available from BAM.

In International seminar on extreme load conditions and limit analysis procedures for structural reactor safeguards and containment structures. Suppl. 2.

In the United States, containment structures and some auxiliary structures (control building, auxiliary building, spent fuel building, etc.) in nuclear power plants are required to be designed to withstand the effects of the design basis tornado. In addition to velocity pressures and missile impact a tornado also gives rise to a rapid change in atmospheric pressure, which can, in cases of closed or partially vented structures, produce direct differential pressure loading. In this paper a digital computer program is described which applies a tornado-induced, time-dependent atmospheric pressure change to a building and calculates the differential pressure histories across the interior and exterior walls of the building. Laws for quasi-steady, one-dimensional motion of an ideal compressible gas are used to calculate the pressures due to the flow of air through ports, doors and windows in the building. Numerical examples show that for each assumed atmospheric pressure change history a vent area to compartment volume ratio may be specified as the criterion for a building to be considered fully vented.

3115 (AED-CONF—75-365-100, pp vp.) **Missile impact on a reinforced concrete structure.** Attalla, I.; Nowotny, B. 1975.

From International seminar on extreme load conditions and limit analysis procedures for structural reactor safeguards and containment structures; Berlin, German, Federal Republic of (F.R. Germany) (8 Sep 1975).

16 figs. With abstract. Available from BAM.

In International seminar on extreme load conditions and limit analysis procedures for structural reactor safeguards and containment structures. Suppl. 2.

An attempt is made to study the behavior of a reinforced-concrete structure under missile impact loading. The local deformations in all directions including wall thickness, plasticity, and stress waves at and surrounding the impact point were taken into consideration. Data are given on the impacting steel missile and the shape of the target concrete wall. As the impacting time is short in comparison to the fundamental eigenfrequency of the structure, it is possible to study the local deformation by isolating the impacted zone and its surroundings from the total structure. The boundaries of this region were considered as fully clamped. The results justified this assumption as the stresses at and near the boundaries were negligible in comparison to their counterpart at the impacting point.

3116 (AED-CONF—75-365-101, pp vp.) **Safety measures within the chemical industry for the protection of nuclear power plants against chemical explosions.** Voigtsberger, P. 1975.

From International seminar on extreme load conditions and limit analysis procedures for structural reactor safeguards and containment structures; Berlin, German, Federal Republic of (F.R. Germany) (8 Sep 1975).

6 refs. Available from BAM.

In International seminar on extreme load conditions and limit analysis procedures for structural reactor safeguards and containment structures. Suppl. 2.

If the primary explosion protection measures within chemical plants are being adhered to, the probability of the formation of large amounts of explodable gas mixtures is kept on such a low level that the risk of a hazard for neighbouring nuclear power plants and for the remaining neighbourhood remains on a justifiable level. In regard to primary protection measures, it is more advantageous to avoid the formation of explodable mixtures rather than to bunker up the whole neighbourhood, i.e. to enclose in pressure-resistant buildings.

3117 (AED-CONF—75-536-001) **Selection of specimens for irradiation programmes in PWR and BWR reactors.** Varga, T.; Njo, D.H.; Prantl, G. 1975. 8p. (In German). (CONF-7510129—1). INIS.

From DVM study group on rupture processes; Aachen, German, Federal Republic of (F.R. Germany) (8 Oct 1975).

5 figs.; 7 refs. With abstract.

The purpose of the irradiation programmes as well as a few of the results obtained with the samples used so far are mentioned.

Difficulties in determining the temperature displacement of the brittle-toughness transition are discussed.

3118 (ANCR-NUREG—1305) **Semiscale Mod-1 program and system description for the reflood heat transfer tests (test series 3).** (Idaho National Engineering Lab., Idaho Falls (USA)). May 1976. Contract E(10-1)-1375. 58p. Dep. NTIS $4.50.

The purpose of the reflood heat transfer test series is to investigate the reflood heat transfer characteristics of the Semiscale Mod-1 electrically heated core which contains rods with 5.5-ft heated lengths. The data provided by these tests are expected to be valuable in the calculation of core and system response during the reflood portion of integral-type tests to be performed later in the Mod-1 program. Presented are descriptions and objectives of the overall Semiscale Mod-1 program and of the reflood heat transfer series; descriptions of the Mod-1 system configuration, test conditions, and test procedures for the reflood heat transfer test series; and descriptions of the Mod-1 data acquisition and processing system used to acquire, process, and present the data reported in the data reports for the reflood heat transfer test series.

3119 (BMI-NUREG—1950) **Fission product transport analysis: Task 2. Quarterly progress report, January—March 1976.** Gieseke, J.A.; Baybutt, P.; Denning, R.S.; Jordan, H.; Wooton, W.O. (Battelle Columbus Labs., Ohio (USA)). 9 Jun 1976. Contract AT(49-24)-0293. 12p. NTIS $3.50.

The escape of fission product activity from a water-cooled reactor under loss of coolant accident (LOCA) conditions is studied. It is the goal of the study to develop a primary system fission product transport and deposition model which is consistent with the emerging state of knowledge regarding fission product release from fuel rods and thermal-hydraulic analyses of emergency core cooling (ECC). The analyses to be developed will provide methods for more realistically calculating the rate and magnitude of fission product release to the containment. An analogous fission product transport and deposition model is also to be developed for spent fuel shipping casks under hypothetical LOCA conditions. Progress during this quarter was primarily in those areas associated with efforts to organize and initiate this study. Technical efforts were initiated (1) to develop the format to be used in the model analyzing fission product transport in pressurized water reactor (PWR) primary systems, (2) to define accidents for shipping casks which result in loss of coolant, (3) to derive from existing computer codes and additional calculations thermal-hydraulic conditions within PWR primary systems, and (4) to determine probable chemical forms for the various fission product species.

3120 (CENPD—135(Suppl.3)) **ATWS model. ATWS model modifications to STRIKIN-II.** (Combustion Engineering, Inc., Windsor, Conn. (USA)). Jun 1976. 18p. Combustion Engineering, Inc., Windsor, CT.

CENPD-135, Supplement 1, "ATWS Model Modifications to STRIKIN-II", was submitted to the NRC in September, 1974. A request for additional information on ATWS was issued by the NRC in a letter dated March 4, 1975. The information in the supplement presented constitutes the C-E response to questions contained in the above NRC letter. All subsequent references to the STRIKIN-II version containing the ATWS models described in CENPD-135, Supplement 1 and this report should refer to STRIKIN-II-ATWS.

3121 (CENPD—135(Suppl.4)) **STRIKIN-II: a cylindrical geometry fuel rod heat transfer program (June 1976 modifications).** (Combustion Engineering, Inc., Windsor, Conn. (USA)). Jun 1976. 107p. Combustion Engineering, Inc., Windsor, CT.

This report details changes made to C-E's ECCS version of the STRIKIN-II code resulting from the findings of an internal audit. Sensitivity studies performed in order to determine the effects on peak clad temperature and peak local oxidation percentage are also documented in the report.

3122 (CENPD—158(Rev.1)) **ATWS analyses. Analysis of anticipated transients without reactor scram in Combustion Engineering NSSS's.** (Combustion Engineering, Inc., Windsor, Conn. (USA)). May 1976. vp. Combustion Engineering, Inc., Windsor, CT.

Results are presented of analyses of the transient thermal-hydraulic conditions and radiological release consequences which would occur in power plants which employ a Combustion Engineering Nuclear Steam Supply System during Anticipated Transients Without Scram due to a lack of insertion of the Control Element Assemblies upon signals for automatic or manual reactor shutdown. The transients analyzed include all events which meet the criterion to be considered as anticipated at least once in the plant lifetime with automatic reactor shutdown.

3123 (CENPD—158(Rev.1)(Suppl.1)) **ATWS analyses. Analysis of anticipated transients without reactor scram in Combustion Engineering NSSS's.** (Combustion Engineering, Inc., Windsor, Conn. (USA)). Jun 1976. 31p. Combustion Engineering, Inc., Windsor, CT.

Responses are presented to all NRC questions concerning transient analyses contained in the "Status Report for Anticipated Transients Without Scram for Combustion Engineering Reactors," dated December 9, 1975, which have not previously been answered in CENPD-158, Revision 1, "Analyses of Anticipated Transients Without Reactor Scram in Combustion Engineering NSSSs," dated May, 1976. The general tenor of the NRC questions is to request justification for assuming operability of certain systems used to mitigate the consequences of an ATWS event, or to provide additional analyses demonstrating the sensitivity of the consequences to the inoperability of these systems. Responses to the majority of requests for justification of system availability require detailed descriptions of the systems as installed at the particular plants and as such can only be provided on a plant-specific basis. Analyses of selected ATWS transients are presented to illustrate the sensitivity of transient consequences to: (1) an uncontrolled boron dilution during the initial 10 minutes of the transient, (2) inoperability of 50 percent of the auxiliary feedwater system capacity, and (3) failure of one CVCS charging pump to provide borated flow. The results of these sensitivity studies indicate the conclusion stated in Section 8.0 of CENPD-158, Revision 1 that "all Class B C-E NSSSs can meet all safety criteria described in Section 1.2" is still valid.

3124 (CENPD—213(Suppl.1)) **Application of FLECHT reflood heat transfer coefficients to C-E's 16 x 16 fuel bundles.** (Combustion Engineering, Inc., Windsor, Conn. (USA)). Mar 1976. 15p. Combustion Engineering, Inc., Windsor, CT.

NRC has approved a FLECHT based reflood heat transfer correlation (designated MOD-1C) for use on the C-E 14 x 14 fuel assembly. This report proposes a procedure for applying the MOD-1C correlation to the C-E 16 x 16 fuel assembly. The procedure applies a non-constant correction factor to the MOD-1C correlation. This correction factor accounts for the geometric differences between the 14 x 14 and 16 x 16 fuel assemblies. Comparison with experimental data corroborates the applicability of the correction method. A computer program called THERM which presents a physical model of the reflood heat transfer process is described. This program was employed to establish the significant parameters involved in the geometric correction factor. Thus, the acceptability of the correction factor is based on the comparisons with experimental data rather than on the THERM program.

3125 (CONF-760643—2) **Central computerized data base for LMFBR safety codes.** Greene, N.M.; Flanagan, G.F.; Alter, H. (Oak Ridge National Lab., Tenn. (USA)). 1976. 10p. Dep. NTIS $3.50.

From 5. CODATA conference; Boulder, Colorado, United States of America (USA) (28 Jun 1976).

The status of the SACRD computerized data retrieval system for fast reactor safety data is described.

3126 (EURFNR—1333) **FLEXA: a convenient FORTRAN program for flexibility and stress analyses of plain piping systems.** Schnauder, H. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Reaktorentwicklung). Jan 1976. 39p. (KFK—2241). Dep. NTIS (US Sales Only) $4.00.

Work performed under United States—Euratom Fast Reactor Exchange Program.

The report describes a method and a computer program for flexibility and stress analyses of plain piping systems located between two fixed anchor points. The program can be used in time sharing operation through TSO (time sharing option of OS/360) as well as in batch operation. Only few data are necessary for the input, e.g. only the length and inclination for a straight piping element and the radius of curvature and the two angles including the bend for a bent piping element. The temperature dependent material data for the types of steel are taken from a program internal library. Besides the usual list output, it is possible to plot the shape of the piping system in a simple true-to-scale drawing. In time sharing operation the representation is achieved via the display, in batch operation via the plotter. Besides the fixed anchor point forces the program also calculates the equivalent stresses at the point of the maximum bending moment as well as the safety with respect to the creep limit.

3127 (FRNC-TH—539) **Experimental and theoretical study of a particular type of transient flow of boiling sodium: flow excursion. Study carried out in the framework of the fast neutron reactor safety.** Schmitt, F. (Grenoble-1 Univ., 38 (France)). 1974. vp. (In French). INIS.

Thesis.

The flow excursion phenomenon was studied in the framework of safety analyses for sodium cooled fast reactors, as a consequence of an accident of pump breakdown without safety rod drop. The experimental study, performed on an out-of-pile circuit with sodium forced convection allowed the flow excursion due to boiling appearance in a single heating channel fed in parallel with a by-pass to be investigated. The first phase is characterized by a relatively slow decay of the (mean) flow rate through the channel from its initial value (corresponding to starting boiling) up to a mean value near zero; its duration, rather important, is of the order of ten or thirty seconds. The second phase appears when the boiling zone occupies an important fraction (half or three quarters) of the heating length of the channel. The mean flow rate has a low value, near zero; the flow rate is oscillatory (chugging) and is formed of vapor plugs parted by liquid bundles. This chugging phase lasts two or three seconds. The computation model developed described simply the boiling liquid flow (homogeneous sliding model) and the heat transfer between the heating medium and the fluid. The transient terms are neglected in continuity and energy equations so as the fluid in the channel is incompressible and its thermal inertia nul.

3128 (GA-A—13933) **Status of safety-related qualification and design verification and support programs in support of HTGR PSARs. Biannual report for period ending February 29, 1976.** (General Atomic Co., San Diego, Calif. (USA)). May 1976. 42p. (GA-LTR—104). General Atomic Co., San Diego, CA.

The scope and magnitude of safety-related programs have been reduced as a result of General Atomic's temporary withdrawal from the commercial power reactor market. The tests that have been suspended are the auxiliary circulator motor cooling and assembly tests, main helium shutoff valve, Plant Protection System module qualification, and main circulator overspeed protection test. No significant effort has been expended on the moisture monitor and control and orificing assembly tests. Studies are reported in the seismic program, core support posts, primary coolant moisture monitor, and core auxiliary cooling system.

3129 (GEAP—21214) **BWR blowdown heat transfer program. Final report.** Muralidharan, R.; Burnette, G.W.; Morrison, A.F.; Muzzy, R.J.; Pastor, E.J.; Sozzi, G.L.; Walker, J.P. (General Electric Co., San Jose, Calif. (USA). Boiling Water Reactor Systems Dept.). Feb 1976. Contract AT(04-3)-189. vp. NTIS $6.00.

System performance and thermal response characteristics of BWR's during the initial blowdown phase under loss-of-coolant accident (LOCA) conditions were investigated in a scaled test apparatus. A number of inherent cooling mechanisms were observed for which no credit is taken in the current BWR LOCA evaluation method. The current method, when applied to the test apparatus, shows a substantial margin in the prediction of peak cladding temperature. Specific phenomenological model improvements are recommended.

3130 (HEDL-TME—75-147) **Fast reactor safety technical progress report, October—December 1975.** Simpson, D.E. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Jun 1976. Contract E(45-1)-2170. vp. AT.

The report presented describes technical progress made during the reporting period, by Westinghouse-Hanford Company and supporting contractors, on fast reactor safety programs. The programs summarized include reactor safety activities supportive of the Fast Flux Test Facility and associated with development of base LMFBR safety technology. The summaries and technical detail are presented.

3131 (INIS-mf—2086) **Advice about the safety aspects of the fuel cycle in the Netherlands.** (Commissie Reactorveiligheid, Voorburg (Netherlands)). Sep 1975. 227p. (In Dutch). INIS.

23 figs., 92 refs., 9 tables.

The Commissie Reactorveiligheid has carried out a study to investigate the rate of release in radioactivity if the installed nuclear power is increased to 35000 MW(e) with BWR and PWR type reactors. A description is given of the structure, organization and responsibilities of the several authorities concerned with the legal aspects, licensing procedures, reactor commissioning and inspection. A description is given of each stage of the fuel cycle as located in the Netherlands. The possibility of released radioactivity is summarized, and guidelines to prevent, minimize or regulate the release of radioactivity are presented. Special attention is given to the nuclear power plant itself, where external effects with regard to the possible release of radioactivity are discussed, such as flooding, sabotage, earthquakes, aircraft collisions, chemical explosions, hurricanes and accidents which can occur during operation of the power plant, or design-basis accidents within the reactor core or inside the reactor building, such as core meltdown, cooling pipe rupture, containment rupture, spent fuel element pool, containers with fuel elements and radioactive waste tanks. Guidelines are given for the physical protection of the nuclear power plant, transport of nuclear materials, and administration of nuclear materials.

3132 (KFK—1901) **RESI-1 and RESI-2: prototypes of an information system on reactor safety.** Schultheiss, G.F.; Eglin, W.; Katz, F.W.; Krings, T.; Pee, A.; Schlechtendahl, E.G. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Reaktorentwicklung; Kernforschungszentrum Karlsruhe (Germany, F.R.). Projekt Nukleare Sicherheit). Apr 1975. 179p. (In German). INIS.

18 refs.; with figs. and tabs.

To demonstrate by practical experience the feasibility of the information system elaborated in the 'Study of an Information System on Reactor Safety RESI' (KFK 1900), the prototype systems RESI-1 and RESI-2 were developed and tested in operation. The two systems have been considerably reduced both in extent and contents as compared to the information system described in the study. The RESI-1 prototype system is a paper version established for verification of all the individual functions before passing over to the computer-aided interactive version RESI-2. RESI-2 is based on the GOLEM system of Siemens. Both protoype systems have proved that the essential features: (1) documentation, (2) formulation of and answering to safety questions, which are relevant with respect to particular licensing cases, and (3) formulation of safety questions related to individual reactor types can be managed satisfactorily. All the functions of information retrieval have been tested carefully over several months. Particularities of project development and of the methods elaborated are described in detail.

3133 (KFK—2217) **Theoretical and experimental methods to determine the properties of molten core components and reaction products. Pt. 2. Final report.** Nazare, S.; Ondracek, G.; Schulz, B. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Material- und Festkoerperforschung; Kernforschungszentrum Karlsruhe (Germany, F.R.). Projekt Nukleare Sicherheit). Oct 1975. 52p. (In German). INIS.

15 refs.; with figs. and tabs.

In the course of a loss of coolant accident, a sequence of events would be initiated that ultimately could lead to core melting. The course of these events and the consequences of core meltdown would in part be determined by the properties of the core materials and the products of their interaction. On the basis of available theoretical and experimental results, the report attempts an estimation of properties such as: 1) work of adhesion between UO_2- and (U,Zr) liquid phase, 2) heat of fusion of some melts, 3) heat capacity of liquid reaction products, 4) viscosity of liquid reaction products, 5) thermal conductivity of liquid reaction products. Experimental work is suggested for those cases where the estimates need to be improved or verified.

3134 (NEDO—13442P-01) **Mark II pressure suppression test program: Phase I tests.** McIntyre, T.R.; Ross, M.A.; Myers, L.L. (General Electric Co., San Jose, Calif. (USA). Boiling Water Reactor Systems Dept.). Jun 1976. 106p. Dep. NTIS $5.00.

Twenth-three blowdown tests were performed to evaluate pool dynamics effects in the Mark II containment geometry. The tests utilized the steam generator and drywell of the Pressure Suppression Test Facility (PSTF) and the Temporary Tall Test Tank (4T) as a combination pool and wetwell air space. The vent geometry was a single 24-in. vertical pipe. Particular emphasis was placed on pool response to a simulated loss-of-coolant accident including pool swell, wetwell pressurization, pool thermal response, and the phenomenon of chugging. Data correlations and phenomenological explanations of the observed data are included.

3135 (NP—20989) **Description of short term program, plant unique torus support systems and attached piping analysis.** (Nutech, San Jose, Calif. (USA)). May 1976. 20p. Dep. NTIS $3.50.

Recently identified pool swell loads have been the subject of detailed studies by the General Electric Company (GE) acting on behalf of the Mark I Owners Group. This work has been done on a generic basis with plant unique considerations being addressed by grouping the plants or actually performing plant unique analysis of a particular component. Similar work has been done to evaluate the torus support systems and external piping attached to the torus. In addition, at the suggestion of the NRC, each utility with an operating plant plans to conduct a plant unique analysis of the torus support system and external piping attached to the torus. The purpose of the document presented is to describe what is being planned as a minimum for these plant unique analyses. The methods of analysis and the loadings which will be used are described briefly. A description is presented of the evaluation criteria which will be used to determine if a plant unique action plan need be developed and discussed with the NRC as a basis for continued operation during the long term program.

3136 (NP—21105) **We did not almost lose Detroit. (A critique of "We almost lost Detroit" by John Fuller).** Page, E.M. (Detroit Edison Co., Mich. (USA)). May 1976. 49p. Detroit Edison Co., MI.

The Book, We Almost Lost Detroit, by John Fuller has been reviewed by those who participated in the Fermi project. The rebuttal presented has been prepared to help correct some of the inaccurate impressions that may be conveyed to the average reader of the book.

3137 (NP—21115) **Status report on anticipated transients without scram for General Electric Reactors.** (Nuclear Regulatory Commission, Washington, D.C. (USA). Office of Nuclear Reactor Regulation). 9 Dec 1975. vp. NTIS.

The review of the GE ATWS analyses included the anticipated transients expected to occur, the initial conditions and system parameter assumed in the analyses, the reliability of systems, the analytical techniques, the results of analyses of ATWS events and the design of the Reactor Protection System. Using the requirements of WASH-1270 as a guideline, the staff reviewed each relevant aspect of the GE model and analysis. The discussion of anticipated transients is presented, and the initial conditions, system parameters and operating systems assumed in the analyses of these transients are also discussed. The analytical techniques and computer programs are reviewed.

3138 (NUREG—0078) **Transient natural convection in an internally heated fluid layer. Topical report, June 1975—June 1976.** Kulacki, F.A.; Emara, A.A. (Ohio State Univ., Columbus (USA). Dept. of Mechanical Engineering). Jun 1976. Contract AT(49-24)-0149. 62p. NTIS $4.50.

An experimental study of the transient response of a horizontal fluid layer subjected to a step change in internal energy generation has been conducted to determine the time scales for the development and decay of natural convection driven solely by the internal heat release. The layer is bounded from above by a rigid, constant temperature surface and from below by a rigid, insulated surface. Two types of unsteady convection processes are considered. In the first, the layer is brought to a motionless, isothermal state, and internal energy generation is suddenly started. In the second, steady natural convection is the initial state, and internal energy generation is suddenly stopped. For both cases, the time required for the development of the final steady state is determined by measuring the temperature response of the fluid with a small thermocouple probe. The time required for the development of the maximum temperature difference in the layer with internal generation and the time required for the complete decay of the maximum temperature difference of steady convection at a given Rayleigh number when internal energy generation is suddenly stopped are correlated with the Rayleigh number in equations which will find general application in PAHR problems in nuclear power reactors and particularly in the analysis of the small-time thermal response of in-vessel and ex-vessel molten core retention devices.

3139 (NUREG—0083) **Safety evaluation report by the Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission for U.S. Energy Research and Development Administration Light Water Breeder Reactor. Special project No. 561.** (Nuclear Regulatory Commission, Washington, D.C. (USA). Office of Nuclear Reactor Regulation). Jul 1976. vp. NTIS $5.50.

The Safety Evaluation Report is presented for the Light Water Breeder Reactor (LWBR). The LWBR core is to be installed in the Shippingport reactor at the Shippingport Atomic Power Station. The Safety Evaluation Report is the result of an NRC staff review of the LWBR Safety Analysis Report submitted by the Division of Naval Reactors, U. S. Energy Research and Development Administration. As a result of its review, the NRC staff has recommended that: (1) a diverse trip signal, such as containment high pressure, be included in a 2-out-of-3 logic for initiation of safety injection; (2) power be locked out from the pressurizer surge isolation valve during normal operation; and (3) a chlorine monitor be installed in the main control room.

3140 (NUREG—0106(Vol.1-2)) **Reflood heat transfer in a light water reactor.** Kirchner, W.L. (Massachusetts Inst. of Tech., Cambridge (USA)). Jan 1976. Contract AT(49-24)-0230. 266p. NTIS $9.00.

Thesis.

The heat transfer processes occurring during the reflood phase of a hypothetical loss of coolant accident are investigated. It was found that peak cladding temperature excursions are terminated by the presence of entrained liquid drops in the vertical flowing vapor stream. This dispersed flow film boiling regime is created due to a complex set of upstream thermal-hydraulic conditions, hence prediction of the reflooding of a rod bundle requires a calculational method which describes the many processes occurring in the bundle during the transient. A physically based calculational method has been developed for prediction of reflood heat transfer. A computer code, REFLUX, was written to provide a framework for making the predictions. The coolant thermal-hydraulic solution is a backward finite difference, single subchannel, one-dimensional solution for the conservation equations of mass, energy, and momentum. The void fraction in the flow boiling regimes is defined by the drift flux model. Provision is made for analyzing non-equilibrium situations encountered under reflood conditions, and a complete two-step dispersed flow film boiling model is included. The coupled fuel-clad temperature field is solved by an implicit finite difference technique for radial conduction, including decay heat generation and temperature dependent material properties.

3141 (ORNL/NUREG/TM—25) **Behavior of iodine, methyl iodide, cesium oxide, and cesium iodide in steam and argon.** Lorenz, R.A.; Osborne, M.F.; Collins, J.L.; Manning, S.R.; Malinauskas, A.P. (Oak Ridge National Lab., Tenn. (USA)). Jun 1976. Contract W-7405-eng-26. 47p. Dep. NTIS $4.50.

An experimental program has been initiated with the overall goal of providing a definitive understanding of fission product behavior under conditions applicable to light water reactor accidents in which the fuel rods reach a maximum temperature in the range 500 to 1300°C. In order to test the apparatus and techniques of analysis, a series of ten experiments was performed in which selected fission product-type compounds were exposed to high-temperature steam and argon atmospheres. The species investigated were I_2, CH_3I, Cs_2O, and CsI, mainly in a steam atmosphere over the temperature range 500 to 950°C. Iodine remained stable at 800°C in steam and argon, but CH_3I decomposed; decomposition rate constants were calculated. Cesium monoxide reacted rapidly with steam to form CsOH (probably the monohydrate) which, in turn, reacted with the quartz furnace tube. Cesium iodide in steam at 700°C decomposed partially by reaction with quartz. Although most of the CsI and the unreacted CsOH was collected in the thermal gradient tube, a small fraction of both these compounds was deposited in the form of particles in the cascade impactor and on the filters.

3142 (ORNL/NUREG/TM—42) **Monthly progress report for June 1976 for the HTGR safety studies for the Division of Systems Safety, U.S. Nuclear Regulatory Commission.** Sanders, J.P. (Oak Ridge National Lab., Tenn. (USA)). Jul 1976. Contract W-7405-eng-26. 6p. Dep. NTIS $3.50.

Progress is reported in the development of the FLODIS and HEXEREI codes for HTGR accident analysis.

3143 (ORO—4958-4) **Two dimensional fuel motion analysis during loss-of-flow accidents in a liquid metal cooled fast breeder reactor. Annual progress report, July 1, 1975—July 1, 1976.** Lal, D.; Carlson, R.W. (Georgia Inst. of Tech., Atlanta (USA). School of Nuclear Engineering). 1976. Contract E(40-1)-4958. 68p. Dep. NTIS $4.50.

An ongoing research program to analyze two dimensional fuel motion in the pre-disassembly stage of a loss-of-flow accident in a liquid metal fast breeder reactor is outlined. The analysis is based on a model channel, consisting of an isolated single fuel pin with cladding and associated subassembly containment structure. A mathematical model is set up to describe the motion of the seven materials of interest: liquid fuel, liquid steel, solid fuel, solid steel, vapor fuel, vapor steel and gaseous fission products. These materials are treated as distinct fields, each with its own equation of density, momentum and energy transport. The various fields are linked together via binary exchange functions for mass, momentum and energy transfer. The exchange functions can be manipulated to give any desired degree of linkage between two fields. The flow analysis is carried through up to the point of loss of subassembly integrity, when a switch to a disassembly code must be made.

3144 (PNC-N—251-74-29) **Development of an analysis code for pressure wave propagation, (1). Analyses of experiment.** Tanaka, Y.; Sakano, K.; Shindo, Y. (Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). Nov 1974. 48p. INIS.

The propagation of the pressure-wave in the piping system of SWAT-1B rig was analyzed by using SWAC-5 Code. Analyses were made on the following parts: (1) A straight pipe; (2) Branches; (3) A piping system. The results obtained in these analyses are as follows: (1) The present model simulates well the straight pipe and the branch with the same diameters; (2) The present model simulates approximately the branch with the different diameters and the piping system.

3145 (SRD-R—50(Pt.1)) **Equation of state for use with sodium. Part I. Theory and computer program.** Alderson, M.A.H.G. (UKAEA Safety and Reliability Directorate, Culcheth). Sep 1975. 41p. Dep. NTIS (US Sales Only) $4.00.

An equation of state has been produced which covers the entire P.V.T. diagram. Thermodynamic consistency has been maintained at all times. The thermodynamic data are presented in the form of tables and a temperature-entropy chart. A computer program has been written to produce the tables and can also be built into other computer programs.

3146 (TID—3362) **Light water reactor safety technical exchange.** (Energy Research and Development Administration, Oak Ridge, Tenn. (USA). Technical Information Center). May 1976. 16p. Dep. NTIS $3.50.

A cumulative list of unlimited distribution reports exchanged between the U.S. Nuclear Regulatory Commission and Germany, France, and Japan for the period November 1974 through December 1975 is presented.

3147 (UCRL—78126) **Reactor safety channel system with on-line testing capability.** Spracklin, H.P. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 22 Apr 1976. Contract W-7405-Eng-48. 9p. (CONF-761006—1). Dep. NTIS $3.50.

From Nuclear science, scintillation and semiconductor counter symposium; New Orleans, Louisiana, United States of America (USA) (20 Oct 1976).

The LPTR (Livermore Pool Type Reactor) safety system had several undesirable features in its original equipment (vintage 1956). A single trip bus, electron tube construction, and trip failure in the case of a shorted magnet actuator, are some of the problems encountered in the original equipment. The continued use of this old equipment resulted in high maintenance costs, excessive magnet actuator replacement, difficult set-up procedures for operations, and the requirement that the reactor be shut down to make safety level trip tests. This paper describes the solution of the stated problems.

3148 (WCAP—7705(Rev.2)) **Testing of engineered safety features actuation system.** Swogger, J.W. (Westinghouse Nuclear Energy Systems, Pittsburgh, Pa. (USA)). May 1976. 130p. Dep. NTIS $6.00.

On-the-line testing of the Engineered Safety Features Actuation system in a typical, as-designed Westinghouse PWR Plant is described. Analog channel testing is performed at the analog instrumentation channels by individually introducing dummy test signals into the instrumentation channels and observing the tripping of the appropriate output bistables. The second phase of testing consists of testing the logic and master relay circuits without actuating the slave relays. During the last phase of testing, the slave relays are actuated to operate groups of final actuation devices wherever possible, without causing plant upset. The as-designed plant includes some final actuation devices and actuated equipment that would not be actuated while at power. These final devices are tested only through to the operation of the respective output relay contact (output blocked) with a continuity check of the final devices actuator coil circuit.

3149 (JPNRSR—35) **Status of research on safety of nuclear power, 1974.** (Japan Atomic Energy Research Inst., Tokyo). [nd]. Translation of Japanese report. 182p. NTIS.

Work performed under United States Nuclear Regulatory Commission—Light Water Reactor Safety Technical Exchange Program.

Reactor safety research at JAERI is summarized in the following areas: nuclear reactor fuels, reactor pressure boundaries, loss of coolant accidents, reactivity accidents, computer codes, environmental radioactivity, and radioactive waste management and disposal.

3150 **Attitude to nuclear energy problems.** Danzmann, H.J. (Institut fuer Reaktorsicherheit der Technischen Ueberwachungs-Vereine e.V., Koeln (F.R. Germany)). *IRS Mitt.*; No. 2, 22-28(1975). (In German).

1 ref.

Two methods are dealt with which show the dialectic shrewdness of some of the active nuclear energy opponents in their attempt to influence opinions. By means of examples of quotations from lectures of recognized scientists (v. Weizsaecker, Teller, Heisenberg, Winnacker) which are torn out of their context, the public are deliberately misled by a few demagogic nuclear power critics.

3151 **Project Nuclear Safety (PNS), state and outlook.** Fischer, M. (Kernforschungszentrum Karlsruhe (F.R. Germany). Projekt Nukleare Sicherheit). *KFK Nachr.*; 7: No. 3, 1-11(1975). (In German).

8 figs.; 2 tabs.; 13 refs.

The PNS deals with the following individual tasks: investigation of the dynamic stresses of reactor pressure vessel components and pressure suppression systems in accidents; investigation of the fuel rod behaviour in loss-of-coolant accidents; investigation of the melting behaviour of LWR fuel elements, of the behaviour of a LWR core melt, of the release and transport of fission products in reactor accidents; development of accident air recirculating filters for the LWR as well as waste gas cleaning for the large reprocessing plant with 1,500 t/a; investigation of probability-evaluated diffusion processes of nuclear noxious substances released in the environment in routine operation and accidents as well as the thus arising radiation exposure; development of techniques for the restriction and removal of accident consequences and for the safe shutdown and final clearing of nuclear plants; and development and application of methods of quantitative risk and reliability analysis for nuclear plants.

3152 **Kernkraftwerke - Muessen wir mit ihnen leben. (Nuclear power plants: Do we have to live with them).** Haber, H. (ed.). Stuttgart, F.R. Germany; Deutsche Verlags-Anstalt (1975). 66p. (In German).

With figs.

This special issue contains contributions concerning technical queries, citizens' reactions to nuclear power plants, questions related to the environment, radiation protection, and the fuel handling system and an article on energy systems offered as alternatives. Professor H. Haber, in his preface, speaks highly of the scientists and engineers who are responsible for the planning, construction, and operation of nuclear power plants.

3153 **Reliability assessment of engineering systems.** Green, A.E.; Bourne, A.J. (UKAEA Systems Reliability Service, Risley). pp 1-26 of In Uncertainty in risk and reliability: appraisal in management. Contributions to a symposium held at Bradford, October 1974. Keller, A.Z. (ed.) (Bradford Univ. (UK)). London; Adam Hilger (1975).

From Symposium on uncertainty in risk and reliability: appraisal in management; Bradford, UK (Oct 1974).

Approaches to reliability assessments and the techniques for such assessments, which have been successfully applied to a variety of systems, including nuclear ones, are outlined. Consideration is given to generic techniques for the evaluation of reliability, criteria to be met, system reliability concepts, and the synthesis of system reliability. The collation, storage, and retrieval of the data is exemplified by the SYREL data bank. Some areas of application are described.

3154 (EURFNR—1274) **Fast Breeder Project. First quarterly report, January 1—March 31, 1975.** (Kernforschungszentrum Karlsruhe (Germany, F.R.)). 1975. Translation of KFK—1275/1. 194p.

For United States—Euratom Fast Reactor Exchange Program.

Progress is summarized in the areas of fuel pin development, material studies and development, corrosion tests and coolant analysis physics experiments, reactor theory, fast reactor safety, core monitoring instrumentation and signal processing, sodium technology tests, thermodynamic and fluid dynamic tests in gas, design studies on gas cooled fast breeders, and sodium cooled breeder design studies.

3155 **Reliability and fault tree analysis. Theoretical and applied aspects of system reliability and safety assessment. Conference held at Berkeley, California, September 3—7, 1974.** Barlow, R.E.; Fussell, J.B.; Singpurwalla, N.D. (eds.). Philadelphia; Society for Industrial and Applied Mathematics (1975). 964p. (CONF-740906—).

From Conference on reliability and fault tree analysis; Berkeley, California, USA (3 Sep 1974).

Separate abstracts were prepared for 31 of the 36 papers included. Abstracts for 5 papers have previously appeared.

3156 **Reliability quantification techniques used in the Rasmussen study.** Vesely, W.E. (US Nuclear Regulatory Commission, Washington, DC). pp 775-803 of In Reliability and fault tree analysis. Barlow, R.E. (ed.). Philadelphia; Society for Industrial and Applied Mathematics (1975).

From Conference on reliability and fault tree analysis; Berkeley, California, USA (3 Sep 1974).

See CONF-740906—.

An overview discussion of the reliability techniques employed in the Rasmussen Nuclear Reactor Safety Study and in particular the techniques utilized in quantifying the accident chain probabilities is presented. The discussion is from a methodological point of view with general approaches and techniques emphasized. Other areas of the study are summarized, when such discussion is needed to help place the quantification methods in proper context.

3157 **Application of the fault tree technique to a nuclear reactor containment system.** Cummings, G.E. (Univ. of California,

Livermore). pp 805-825 of In Reliability and fault tree analysis. Barlow, R.E. (ed.). Philadelphia; Society for Industrial and Applied Mathematics (1975).

From Conference on reliability and fault tree analysis; Berkeley, California, USA (3 Sep 1974).

See CONF-740906—.

A fault tree analysis of a pressurized water reactor containment system is described. The analysis is used to determine the probability of excessive leakage of containment atmosphere following a loss-of-coolant accident. Emphasis is placed on the preliminary steps taken to make the analysis of such a large, complex system manageable. The final result is a reduced fault tree which describes only the main failure paths and to which component failure rate data can be applied to obtain a quantitative result.

3158 Foundation considerations for a nuclear power plant. Faillace, G.A. (Dames and Moore, Park Ridge, Ill). *J. Constr. Div., Am. Soc. Civ. Eng.;* **101**: No. 1, 165-181(Mar 1975).

The evaluation of a site for a nuclear power plant involves consideration of numerous factors relating to the physical and environmental aspects, as well as compliance with many regulations and regulatory bodies. A case study is presented on one of these factors, i.e., foundations. A coordinated field exploration program followed by a comprehensive laboratory program and detailed foundation engineering analyses indicated that some of the site's granular soils were marginal with respect to the foundation support of the proposed power plant structures. A review of alternate foundation support schemes revealed that excavation and recompaction of the soils would provide suitable foundation support. The supporting sands were enclosed in an impermeable clay envelope to preclude the possibility of strength loss during liquefaction of adjacent sands during earthquake loading. A comprehensive quality assurance program was established during fill placement to ensure compliance with the specified placement and compaction criteria.

3159 Democracy put to the test. Matthoefer, H. (Bundesministerium fuer Forschung und Technologie, Bonn (F.R. Germany)). *Umwelt;* No. 5, 4(Oct 1975). (In German).

The Federal Ministry for Research and Technology announced a campaign on the subject nuclear energy in connection with the controversy about the forced use of nuclear reactors to cover the energy demand. The aim of this campaign is to strengthen or to recreate the faith of the population in the functioning of democratic processes, also and especially in the nuclear energy controversy. Based on this, an attempt is made to get a wide consensus on requirements, safety and reasonable exposure. The Federal Government only wants to urge on promotion and development within this consensus.

3160 The human factor influencing the safety of nuclear facilities. Berg, K.H.; Fechner, J.B. (Bundesministerium des Innern, Bonn (F.R. Germany)). *Atomwirtsch., Atomtech.;* **20**: No. 11, 556-558(Nov 1975). (In German).

1 fig.; 18 refs.

Nuclear facilities in all their safety ramifications must be considered as man-machine systems because man as a 'liveware' is at least as important in ensuring safety as are hardware and software. The article deals with a number of measures initiated or suggested by the German Federal Ministery of the Interior to put more emphasis on this finding and its evaluation in practical nuclear safety measures in the Federal Republic of Germany. This includes both the improvement of hardware and software in the light of the results of occupational studies and efforts to improve the qualifications of plant personnel and the consultants employed by public authorities.

3161 Power reactor safety analysis. General principles and practical applications. *Bull. Inf. Sci. Tech. (Paris);* No. 208, 25-39(Nov 1975). (In French).

The method used in France for the technical safety analysis of nuclear power plants by the Commissariat a l'Energie Atomique (CEA) on behalf of the departmental authorities responsible for granting construction and operation licences under the terms of standing agreements.

3162 Nuclear plant safety. Jouannaud, C. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Bureau d'Evaluation de Surete des Laboratoires et Usines). *Bull. Inf. Sci. Tech. (Paris);* No. 208, 41-48(Nov 1975). (In French).

French regulations governing nuclear plants other than reactors are reviewed. The problems raised by the different fuel cycle plants are mentioned together with the risks encountered. Emphasis is laid on the importance of the definition of safety principles which, if correctly applied, will allow a satisfactory safety standard to be reached and maintained throughout the lifetime of the plant and under all circumstances. Methods of safety analysis are then developed.

3163 Reactor safety and site selection. Tanguy, P. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. de Surete Nucleaire). *Bull. Inf. Sci. Tech. (Paris);* No. 208, 5-10(Nov 1975). (In French).

A definition of nuclear plant safety is given and the methods and procedure adopted are outlined. The possibilities offered by probabilistic studies are shown and the value of studies and research conducted in the safety field is emphasized. The problem of interaction between the site and the plant is extremely important. The benefits of international cooperation in the matter of nuclear safety are stressed.

3164 System safety: theory and practice. Koehnlein, W. *Arbeitsschutz (Cologne);* No. 11;12, 433-436(Nov 1975). (In German).

4 refs.

The essentials of system safety analysis methods are briefly dealt with, and the application of these methods is shown by a few examples from nuclear engineering.

3165 Use of reliability and probability methods in reactor safety. Carnino, A. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. de Surete Nucleaire). *Bull. Inf. Sci. Tech. (Paris);* No. 209, 15-22(Dec 1975). (In French).

After the terms used in reliability are briefly recalled, the methods used for evaluating the probability of system failure and accident probability are discussed: event trees, failure trees, and logical diagrams. Some results taken from the first complete probabilistic approach of accidents, the WASH 1400 report (Reactor Safety Study) are also given.

3166 File of accidents. Carnino, R. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service d'Etudes Techniques de Surete). *Bull. Inf. Sci. Tech. (Paris);* No. 209, 59-61(Dec 1975). (In French).

The Nuclear Safety Department of the CEA keeps a file in which are entered all mishaps to French reactors. This file is described briefly.

3167 Technical safety studies. Ringot, C. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. de Surete Nucleaire). *Bull. Inf. Sci. Tech. (Paris);* No. 209, 5-14(Dec 1975). (In French).

After the role played by safety analysis has been evoked, it is shown how it is organized in the Commissariat a l'Energie Atomique. Examples dealing with nuclear power stations and concerning internal aggression (summary of accidents likely to occur in a power station) and external aggression (natural or man-made) are given.

3168 Safety of the pressure vessels of water reactors. Prevention of sudden failure. Petrequin, P. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. de Technologie); Barrachin, B. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. de Surete Nucleaire). *Bull. Inf. Sci. Tech. (Paris);* No. 209, 43-58(Dec 1975). (In French).

From the safety view point the primary circuit is considered as the essential barrier against the diffusion of radioactive products in the event of fuel element failure. The safety of the vessel itself, the failure of which is not accounted for in accident analyses, is based chiefly on a series of preventive measures such as the suitable choice of materials and manufacturing process, compliances with detailed specifications concerning tests and defect tolerances, and supervision in service. All these points are examined in detail when the safety analysis is performed. In this context the Service de Recherches Metallurgiques Appliquees assists the Department de Surete Nucleaire in the study of special problems such as the prevention of sudden failure and the characterisation of steels as a function of working conditions, particularly neutron irradiation. The report presented is devoted mainly to the presentation of methods to prevent sudden failure, with special emphasis on the limits of application. Some results obtained at the Service de Recherches Metallurgiques Appliquees on steels typical of those used for water reactor vessels (A533 and A508Cl.3) are given by way of example. Part two concentrates on the role of various factors influencing embrittlement by irradiation.

3169 The nuclear debate in Sweden. Sandstrom, S. (AB Atomenergi). *Nucl. Eng. Int.;* **21**: No. 238, 50-52(Jan 1976).

The current preoccupation with conservation among widespread factions in the Swedish populace dates back to the 1960's. Co-ordinated by a central organisation, Miljocentrum, a variety of environmental protection groups concentrated at first on such things as fluorine in drinking water, colouring matter in foodstuffs, poisonous industrial effluents such as phosphates in detergents and mercury. In the early 1970's attention became more and

more directed against nuclear energy, the arguments generally following the same lines as the U.S. debate but with some time lag. Nuclear energy has since become the focal point of environmental protest both among the public and within parliament. Public opposition to a reprocessing plant site at Sannas may lead to a decision to opt for a 'fuel cycle centre' on a site suitable for final disposal of high level radioactive waste.

3170 Brown Boveri's contribution to the safety of nuclear power stations. Hentschel, G. *Brown Boveri Rev.*; **63**: No. 1, 5-16(Jan 1976).

The first part of the report is concerned with the safety of nuclear power stations and also describes the measures which are taken to ensure that the operation of such power stations is technically safe. In the second part consideration is given to external influences. A concept is introduced by which a nuclear power station can be effectively protected against such influences.

3171 Nuclear power plant safety and hazards. Synek, S. *Jad. Energ.*; **22**: No. 4, 146-148(Apr 1976). (In Czech).

The definition of nuclear power plant safety and hazards is presented. A brief description is given of the probabilistic and of the deterministic methods of ascertaining the risks and the consequences of nuclear facility accidents. The importance is stressed of safety criteria, safety regulations, and licensing procedures pertaining to nuclear installations. Standardization of the individual parts of nuclear facilities should serve the attaining of increased reliability and safety thereof, a shortening of the construction time, and a more speedy and simple licensing.

3172 Current problems of accident protection of liquid sodium-fired steam generators. Matal, O. (Vyzkumny Ustav Zavodu Energetickeho Strojirenstvi, Odbor Nuklearni Techniky, Brno (Czechoslovakia)). *Jad. Energ.*; **22**: No. 4, 125-127(Apr 1976). (In Czech).

The problems of accident protection of the liquid-sodium fired steam generator are illustrated by some results of the calculation of the changes in the operating medium parameters and the changes in the structural material properties resulting from tightness of the steam generator heating surface. The requirements for accident protection are briefly listed.

3173 Pool swell in a nuclear containment wetwell. Fernandez, T. *EPRI J.*; **1**: No. 3, 21-23(Apr 1976).

A brief description is presented of scale model tests conducted to study LOCA induced wetwell pool swelling in the BWR Mk I containment pressure suppression system. The Mk I containment configuration is described together with the scale model design, the conduct of the tests, and the experimental results. (DG)

3174 Research program for the sodium loop safety facility. Gartside, C.H.; Bezella, W.A.; Lennox, D.H. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.*; **23**: 319(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3175 Sodium loop safety facility in-pile experiment P1. Herceg, J.E.; Pierce, R.D.; Anderson, T.T.; Blomquist, C.A.; Borys, S.S.; Kuzay, T.M.; Miles, K.J.; Ragland, W.A.; Thompson, S.D.; Wilson, R.E. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.*; **23**: 319-320(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3176 Acoustic monitoring of the SLSF P1 test. Carey, W.M.; Anderson, T.T.; Bobis, J.P.; Gavin, A.P.; Pedersen, D.R. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.*; **23**: 320-321(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3177 Heat transfer predictions for the SLSF P1 hexcan. Hwang, I.T.; Wang, P.Y.; Tessier, J.H. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.*; **23**: 321-322(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

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3248 Nuclear power is better for your health. Burnett, T.W.T.; Paddleford, D.F. (Westinghouse Electric Corp., Pittsburgh). *Trans. Am. Nucl. Soc.*; **23**: 316-317(Jun 1976).

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3249 Missile hazard from explosions near nuclear plants. Hornyik, K,; Earle, O.K. (Oregon State Univ., Corvallis). *Trans. Am. Nucl. Soc.*; **23**: 317-318(Jun 1976).

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3250 Theory of heat transfer between two gases in a mixture. Kalimullah. (Argonne National Lab., IL). *Nucl. Sci. Eng.*; **60**: No. 3, 311-314(Jul 1976).

Starting from the mechanics of collision between two perfectly elastic smooth spherical molecules, an equation for the heat transfer rate per unit volume from a gas or vapor to another gas in a mixture is derived based on the kinetic theory of gases. Methods of estimating molecular diameters when experimental values are not available are indicated, and values for sodium and UO_2 vapor are estimated. For a set of typical values of the parameters, the time constant for the heat transfer is found to be of the order of 10^{-8} sec, which implies that for processes occurring in time periods greater than those of the order of 10^{-8} sec, the gases can be assumed to come to a thermal equilibrium at the instant they mix.

3251 (NR-tr—001) Recommendations of the Reactor Safety Commission, 1971—1974. (Institut fuer Reaktorsicherheit der Technischen Ueberwachungs-Vereine e.V., Koeln (Germany, F.R.)). Jul 1976. Translation of IRS-A—9. 205p. NTIS $7.75.

The Reactor Safety Commission (RSC) of the German Federal Republic was created in 1958 by the then Federal Minister for Atomic Energy and Hydroeconomy. Its task included the advising of the Federal Minister responsible for protection of the population from possible dangers occurring during peaceful utilization of nuclear energy and in all matters of the safety of nuclear oriented installations. The RSC consists of independent experts from differing specialty areas. The results of their consultations are passed on in recommendations to the appropriate Federal Minister. Since the reappointment and reorganization of the RSC in the year 1971 by the then Federal Minister for Education and Science, the recommendations have been published in the "Federal Gazette." The report presented is divided into two parts with a three part appendix. All recommendations of the RSC made since the reorganization (68th Meeting on 3 November 1971) until expiration of the last appointment, (96th Meeting on 25 July 1974) are compiled in the first section. The second part contains all announcements of the RSC which have appeared in the "Federal Gazette." These concern training, agenda, as well as current members. Appendix A includes the "Guidelines for Pressurized Water Reactors" approved in the 93rd Meeting on 24 April 1974. Two key word listings follow in Sections B and C of the Appendix. The report was prepared in behalf of the Federal Minister of the Interior through the Office of the RSC assigned to the Institute for Reactor Safety of the Technical Inspection Association (IRS). The report is continued at regular intervals following each meeting period.

ACCIDENT LIABILITY

REFER ALSO TO CITATION(S) 2921, 2936

ENERGY STORAGE

COMPRESSED GAS

3252 (BNWL—2065) Technical and economic feasibility analysis of the no-fuel compressed air energy storage concept. Kreid, D.K. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). May 1976. Contract E(45-1)-1830. 71p. Dep. NTIS $4.50.

The principal goal of this study was to evaluate the technical and economic feasibility of no-fuel compressed air energy storage (CAES) concepts for utility peaking applications. The analysis uncovered no insurmountable problems to preclude the technical feasibility of the no-fuel CAES concept. The results of the economic analysis are sufficiently unfavorable to conclude that no-fuel CAES technology could not compete with conventional CAES or standard gas turbine peaking facilities for conditions foreseeable at this time.

FLYWHEELS

3253 (UCRL—78085) Composite fiber flywheel for energy storage. Rinde, J.A.; Chiao, T.T.; Stone, R.G. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 4 Jun 1976. Contract W-7405-Eng-48. 21p. (CONF-761018—1). Dep. NTIS $3.50.

From 8. Society for the Advancement of Material and Process Engineers technical conference; Seattle, Washington, United States of America (USA) (12 Oct 1976).

The use of the flywheel as an energy storage device has received widespread interest in the last two years. Because of their high strength-to-density ratio, relatively inexpensive fabrication process, and low safety hazards, composite materials offer great potential for efficient flywheel design. Key portable and stationary applications of the flywheel are discussed and examples of those presently under consideration at LLL are described in some detail. Design data on key candidate composite material systems are reported and areas that require further extensive study are also discussed. In addition, on-going programs, including those at LLL, are summarized.

THERMAL

REFER ALSO TO CITATION(S) 2660

3254 (EIR—294) **"Cold" storage/transport of thermal energy up to 260°C.** Taube, M. (Eidgenoessisches Inst. fuer Reaktorforschung, Wuerenlingen (Switzerland)). Mar 1976. 42p. Dep. NTIS (US Sales Only) $4.00.

The substances containing hydrogen bonds seem to be preferred for the "cold storage" and "cold transport" of thermal energy in the range of up to 260°C. The criteria for selecting these substances are discussed. For the sake of illustration the following systems are discussed in more detail: (a) storage of thermal energy at approximately 260°C for power peaking with the help of latent heat of a eutectic of sodium hydroxide, (b) ammonia-water system for space heating, cold storage, and transport, and (c) ammonia-molten salts (e.g., aluminium trichloride-sodium chloride eutectic) as a system for power peaking storage and/or cold transport of heat for industrial users of steam (approximately 260°C, 60 bar) and/or district heating by means of railway transport.

BATTERIES

REFER ALSO TO CITATION(S) 3355

3255 (ANL—76-8) **Proceedings of the symposium and workshop on advanced battery research and design, March 22—24, 1976.** Selman, J.R.; Steuenberg, R.K.; Barghusen, J.J.; Howard, W.G. (eds.). (Argonne National Lab., Ill. (USA)). 1976. vp. (CONF-760312—). Dep. NTIS $12.75.

From Battery workshop; Argonne, Illinois, United States of America (USA) (21 Mar 1976).

Separate abstracts are presented for 30 of the papers in these proceedings. An additional paper has already been cited in ERA. (RWR)

DESIGN AND DEVELOPMENT

REFER ALSO TO CITATION(S) 2657, 3305, 3308, 3309

3256 (ANL—76-8, pp A.34-A.48) **Lead—acid battery.** Simon, A.C. (Naval Research Lab., Washington, DC); Caulder, S.M. 1976.

From Battery workshop; Argonne, Illinois, United States of America (USA) (21 Mar 1976).

In Proceedings of the symposium and workshop on advanced battery research and design, March 22—24, 1976.

The lead—acid battery has shown a slow but steady development over the years of its history. Most of its improvements have been obtained through engineering development, and there has been relatively little basic research. At a period when there is the possibility of two major markets for batteries, those of energy storage and electric vehicles, one should not too soon dismiss this battery from consideration. Although at present marginal for both of these applications, there is the distinct possibility that with the proper research the life and energy density of this battery can be increased to the point where it may look a lot more attractive than at present. Some of the problem areas and possible solutions are discussed.

3257 (ANL—76-8, pp A.49-A.65) **Current status and prospects of the Zn—air and Na—S batteries in France.** Appleby, A.J. (Laboratoires de Marcoussis, France); Gabano, J.P. 1976.

From Battery workshop; Argonne, Illinois, United States of America (USA) (21 Mar 1976).

In Proceedings of the symposium and workshop on advanced battery research and design, March 22—24, 1976.

The Compagnie Generale d'Electricite is currently conducting development work on both a circulating-slurry zinc—air battery with either built-in or external recharging facility and on the sodium—sulfur—β-alumina battery. The first system promises to be effective vehicle power unit with sufficient energy density to give useful vehicle performance (110W Wh/kg : about 150 km range for a practical city-car with normal payload). Power units were extensively tested over the past three years in the form of laboratory modules, and sufficient data to predict practical lifetime, performance, and manufacturing cost were obtained. An upper-limit system cost of $40 (1974)/kW is expected. Practical lifetime will be at least 2000 running hours. The sodium—sulfur battery, whose development time will be longer, may be applied to either vehicles or to industrial purposes for which the efficiency of the zinc—air system (40 percent overall) is not sufficiently high (e.g., offpeak storage). Over 6000 cycle (24000 hours total) have been obtained with laboratory cells using pure β-alumina electrolytes. Problems that must be solved to develop practical battery systems are summarized. 7 figures, 1 table.

3258 (ANL—76-8, pp A.81-A.97) **High-temperature batteries.** Cairns, E.J.; Dunning, J.S. (General Motors Corp., Warren, MI). 1976.

From Battery workshop; Argonne, Illinois, United States of America (USA) (21 Mar 1976).

In Proceedings of the symposium and workshop on advanced battery research and design, March 22—24, 1976.

The state of the art for high-temperature batteries is presented and discussed. Emphasis is given to the lithium alloy/metal sulfide and sodium/sulfur cells. Other systems considered include lithium/chlorine and sodium/metal halide. Cell chemistry and performance and life-limiting factors are reviewed for all systems, and the status of investigations in critical problem areas is given. Recent advances in the demonstration of high specific energy and expectations for future improvement are presented. 11 figures, 4 tables.

3259 (ANL—76-8, pp A.99-A.106) **Comparison of U.S. and European high-temperature battery programs.** Nelson, P.A. (Argonne National Lab., IL). 1976.

From Battery workshop; Argonne, Illinois, United States of America (USA) (21 Mar 1976).

In Proceedings of the symposium and workshop on advanced battery research and design, March 22—24, 1976.

Most of the present effort on high-temperature batteries, both in the U.S. and in Europe, is directed toward the development of sodium/sulfur and lithium/metal sulfide systems. This paper describes the major programs on both continents, and compares the economic incentives for battery development, the intended applications, the cell and battery designs, and the unsolved technical problems. Also discussed is the increased effort that is needed in the areas of battery design and development of low-cost components to produce batteries that are economically attractive for the intended applications. 1 table.

3260 (ANL—76-8, pp B.210-B.218) **Development of uncharged Li—Al/FeS cells.** Shimotake, H.; Bartholme, L.G. (Argonne National Lab., IL). 1976.

From Battery workshop; Argonne, Illinois, United States of America (USA) (21 Mar 1976).

In Proceedings of the symposium and workshop on advanced battery research and design, March 22—24, 1976.

Cells having negative electrodes of lithium—aluminium alloy and positive electrodes of iron sulfide (FeS) are being developed at Argonne National Laboratory for energy storage batteries to be used for utility load-leveling. This paper describes a Li—Al/FeS cell that is assembled in the uncharged state. The principal difference from previous cells is in the method of preparing the positive electrode; in this method Li_2S, iron powder, and electrolyte salt are blended and hot-pressed into a plaque (copper powder was also included in some of the electrodes). The use of this type of electrode overcame many previous difficulties, primarily excessive swelling, low utilization, and gassing. The new cells showed outstanding performance, with utilizations and energy efficiencies exceeding 85 percent at the 10-h rate. 6 figures, 1 table.

3261 (ANL—76-8, pp B.219-B.230) **Sodium/sulfur battery: a progress report.** Weiner, S.A. (Ford Motor Co., Dearborn, MI). 1976.

From Battery workshop; Argonne, Illinois, United States of America (USA) (21 Mar 1976).

In Proceedings of the symposium and workshop on advanced battery research and design, March 22—24, 1976.

Work on sodium—sulfur cells is presented, with emphasis on various aspects of cell design and testing. The baseline studies for the cell testing program were run on cells that were constructed of carbon and glass and contained no metal other than sodium. Separate cells, designed to maximize energy and power density were studied. A preliminary discussion of materials costs is included. 8 figures, 5 tables.

3262 (ANL—76-8, pp B.239-B.251) **Current status of the Atomics International lithium—iron sulfide battery development.** Heredy, L.; McCoy, L.; Sudar, S. (Rockwell International, Canoga Park, CA). 1976.

From Battery workshop; Argonne, Illinois, United States of America (USA) (21 Mar 1976).

In Proceedings of the symposium and workshop on advanced battery research and design, March 22—24, 1976.

A program for the development of lithium—iron sulfide batteries for electric utility load-leveling is being conducted at Atomics International. These batteries use a molten KCl—LiCl electrolyte and are operated at a temperature of 400°C or higher.

A lithium—silicon alloy, Li_xSi, is used as the active material in the negative electrodes. Positive electrodes contain the iron sulfides FeS, FeS_2 or their mixture. Electrode development tasks are concerned with minimizing the cost of supporting structures and optimizing electrode performance. Porous ceramic separators based upon rigid structural materials are being developed. Rigid separators used in current experimental cells are either prepared by processes under development or are purchased. Cell development is being conducted through scale-up stages involving increasing electrode area and numbers of parallel connected electrodes to reach a 2.5 kWh modular cell. A status review of this effort is presented. 8 figures, 1 table.

3263 (ANL—76-8, pp B.252-B.262) **High temperature rechargeable cells with doped CaF_2 as a solid electrolyte.** Baukal, W. (Battelle-Institut E.V., Frankfurt/Main); Kuhn, W.; Voss, E. 1976.

From Battery workshop; Argonne, Illinois, United States of America (USA) (21 Mar 1976).

In Proceedings of the symposium and workshop on advanced battery research and design, March 22—24, 1976.

Doped calcium fluoride is applied as a solid electrolyte for high-temperature secondary cells using calcium and copper fluoride as electrode materials. The cell reaction is given by the equation $Ca + CuF_2$ in equilibrium $CaF_2 + Cu$. The cell voltage is measured to be 3.37 V at 450°C, which is in good agreement with the value of 3.39 V calculated from thermodynamic data. Results obtained on cycling experiments are reported. 7 figures, 3 tables.

3264 (ANL—76-8, pp B.264-B.276) **Modeling approaches for molten-salt lithium/sulfide batteries.** Hickman, T.E.; Kolba, V.M. (Argonne National Lab., IL). 1976.

From Battery workshop; Argonne, Illinois, United States of America (USA) (21 Mar 1976).

In Proceedings of the symposium and workshop on advanced battery research and design, March 22—24, 1976.

Methods are being sought for accurately predicting the behavior of lithium—aluminum/iron sulfide molten-salt batteries being developed at Argonne National Laboratory for electric-vehicle propulsion and off-peak energy storage on utility networks. The successful application of an analytical model would aid in design optimization studies and design iteration and testing. A literature search to determine the state of the art of electrochemical cell modeling showed that little work has been done on the modeling of cells having molten salt electrolytes. This paper presents a summary of information gained in the survey and the results obtained when several existing models were applied to data taken at the terminals of Li—Al/FeS and Li—Al/FeS_2 test cells. The present effort is expected to lead to a model which provides complete characterization of the cell and battery components, and thus allows optimization of cell and battery design. 6 figures, 1 table.

3265 Zinc—bromine storage Battery for electric vehicles. Clerici, G.; de Rossi, M.; Marchetto, M. (Magneti Marelli battery Labs., Milan). pp 167-181 of In Power sources 5. Collins, D.H. (ed.). New York; Academic Press Inc. (1975).

From 9. international power sources symposium; Brighton, UK (17 Sep 1974).

See CONF-740908—.

Constructional features, performance and life testing of a prototype zinc—bromine storage battery for an electric city vehicle are described. Designed, built, and experimented with in the laboratory with promising results, this battery makes use of thin bipolar titanium electrodes, zinc being deposited on the negative and bromine on the positive side. Titanium passivation is prevented by coating the positive side of the bipolar titanium electrode with conductive ceramic oxides. An aqueous electrolyte is used consisting of a concentrated solution of zinc bromide acidified to pH 1.5—2 with bromic acid, and circulated through each cell.

3266 Performance of iron—air secondary cells under practical operation conditions. Cnobloch, H.; Groeppel, D.; Kuehl, D.; Nippe, W.; Siemsen, G. (Forschungslaboratorien der Siemens AG, Erlangen, Ger.). pp 261-282 of In Power sources 5. Collins, D.H. (ed.). New York; Academic Press Inc. (1975).

From 9. international power sources symposium; Brighton, UK (17 Sep 1974).

See CONF-740908—.

The cell consists of an iron electrode, working on both sides, which is opposed by two air electrodes. During the charging and discharging of metal—air cells, water evaporates from the electrolyte. The losses can be compensated for by flooding the gas spaces of the air electrodes with water during the charging phase. Potassium hydroxide solution serving as electrolyte absorbs carbon dioxide from the air. The carbon dioxide is removed by a newly developed process, in which the air streams around porous matter soaked with absorbing liquid. Parallel with the reduction of iron, hydrogen is evolved. By using copper instead of nickel as supporting material the hydrogen evolution rate can be markedly decreased.

3267 Iron—air battery systems for traction purposes. Lindstroem, O. (Royal Inst. of Tech., Stockholm). pp 283-301 of In Power sources 5. Collins, D.H. (ed.). New York; Academic Press Inc. (1975).

From 9. international power sources symposium; Brighton, UK (17 Sep 1974).

See CONF-740908—.

The iron—air battery is a promising power source with a high energy density for qualified traction applications. Prototype systems have been tested in underground operations. Results and experiences obtained so far in the project are summarized.

3268 Rechargeable nickel—zinc cell with an auxiliary electrode. Benczur-Uermoessy, G.; von Benda, K.; Haschka, F. (Deutsche Automobilgesellschaft mbH, Esslingen, Ger.). pp 303-314 of In Power sources 5. Collins, D.H. (ed.). New York; Academic Press Inc. (1975).

From 9. international power sources symposium; Brighton, UK (17 Sep 1974).

See CONF-740908—.

A nickel—zinc cell with soluble zinc anodes and an auxiliary electrode has been devised which effectively overcomes the problems of dendrites and shape change. The auxiliary electrode acts as a dendrite barrier during charge and prevents shape change by dissolution of residual zinc after discharge. At the 1 h rate, a 4 A h cell has delivered about 30 W h/kg for over 1200 cycles, and a 8 A h cell has attained 38 W h/kg.

3269 Sealed metal oxide—hydrogen secondary cells. Dunlop, J.; Stockel, J.; van Ommering, G. (COMSAT Labs., Clarksburg, MD). pp 315-329 of In Power sources 5. Collins, D.H. (ed.). New York; Academic Press Inc. (1975).

From 9. international power sources symposium; Brighton, UK (17 Sep 1974).

See CONF-740908—.

Two new types of sealed metal oxide—hydrogen secondary cells, the nickel hydroxide—hydrogen (Ni—H_2) and the silver oxide—hydrogen (Ag—H_2) cells, are being developed for lightweight, long-life, rechargeable batteries. Laboratory Ni—H_2 cells have already demonstrated over 10,000 cycles at 28 percent depth of discharge. The first series of light weight 50 A h cells, now under test, has a measured energy density of 55 W h/kg with a maximum cell operating pressure of 30 atm (3 MN/m^2). An alternative approach is chemical storage of the hydrogen in the form of a hydride. Using $LaNi_5$ for storage of hydrogen, cells typically operate at less than 4 atm (405 kN/m^2) of pressure. When energy density is the major consideration, the Ag—H_2 system appears very promising. While these cells do not have the cyclic life expectancy of the Ni—H_2 cells, their energy density is about 50 percent greater (70—90 W h/kg).

3270 Sealed, rechargeable silver—hydrogen battery. Klein, M. (Energy Research Corp., Bethel, CT). pp 347-359 of In Power sources 5. Collins, D.H. (ed.). New York; Academic Press Inc. (1975).

From 9. international power sources symposium; Brighton, UK (17 Sep 1974).

See CONF-740908—.

The silver—hydrogen couple represents the marriage of the rechargeable hydrogen electrode, of the fuel cell type, and the silver electrode used in silver—zinc batteries. This battery system is capable of delivering energy densities in the 75—100 W h/kg range at approximately 10 W h/cm^3 depending on cell size and rate of discharge. The mechanical approach taken for the cell construction is a single cylindrical cell in which the electrode stack is placed. The stack consists of repeating layers of silver electrodes, separator material, bifunctional hydrogen electrodes, and gas diffusion screens. The stack of disc electrodes is assembled within a cylindrical shaped pressure vessel which serves as a hydrogen storage container and a cell housing. During charge hydrogen gas is generated on the surface of the hydrogen electrode and is stored within the void volume of the cell housing. During discharge the hydrogen gas is reacted on the fuel cell electrode. The operating pressure range of typical cells is 6.8—34 atm (0.7—3.5 MN/m^2) of hydrogen. Platinum hydrophobic fuel cell electrodes are utilized as the negative electrodes, composite layers of inorganic separator materials are used for the separator and sintered silver electrodes have been used for the positives. Complete 25 A h light-weight cells have been assembled and tested. The advantages of this system include insensitivity to over-charge, continued float and reversal, high energy density and long cycle life.

3271 Experimental aluminum—sulphur cell. Redey, L.; Porubszky, I.; Molnar, I. (Technical Univ., Budapest). pp 559-572 of In Power sources 5. Collins, D.H. (ed.). New York; Academic Press Inc. (1975).

From 9. international power sources symposium; Brighton, UK (17 Sep 1974).

See CONF-740908—.

Anodic and cathodic behavior of Al and a S impregnated porous carbon body has been examined in $AlCl_3$—NaCl—KCl melt. On the basis of these experimental results cells 40 mm in diameter by 80 mm in height have been constructed and studied. The experimental Al—S cells are capable of operating between 100°C and 350°C. However, the best results can be achieved in the temperature range of 200—300°C. A cup-shaped Al anode itself covers the cell which can be completely sealed because of the absence of gaseous materials. There is no need for a diaphragm. Experience has proved the rechargeability of this system. The cell construction described is not really adequate to give a high power density, although it indicates the feasibility of the Al—S galvanic system.

PERFORMANCE AND TESTING

REFER ALSO TO CITATION(S) 3267, 3268, 3269

3272 (ANL—76-8, pp A.66-A.80) **Batteries for electric vehicles in western Europe.** Lander, G.; Voss, E. (Forschungs- und Entwicklungszentrum der VARTA Batterie AG, Kelkheim/Taunus, Ger.). 1976.

From Battery workshop; Argonne, Illinois, United States of America (USA) (21 Mar 1976).

In Proceedings of the symposium and workshop on advanced battery research and design, March 22—24, 1976.

In western Europe a number of electric vehicle projects are currently underway. At present all vehicles are powered by lead—acid batteries. Lead—acid cells operate at an energy density of 30 to 40 Wh/kg depending on cell design. Cycle life is in the range of 500 to 1600. Maintenance has been reduced to a minimum. The capability of lead—acid batteries to power vehicles for city transport has been demonstrated. 10 figures, 4 tables.

3273 (ANL—76-8, pp B.138-B.151) **Rechargeable calcium high-temperature cells.** Preto, S.J.; Ross, L.E.; Martin, A.E.; Roche, M.F. (Argonne National Lab., IL). 1976.

From Battery workshop; Argonne, Illinois, United States of America (USA) (21 Mar 1976).

In Proceedings of the symposium and workshop on advanced battery research and design, March 22—24, 1976.

Calcium is an attractive negative electrode material for use in secondary cells because of its great abundance, low equivalent weight, and high reaction energy. In this study, a number of secondary, molten-salt calcium cells having capacities of up to 20 Ah were evaluated in terms of their charge—discharge characteristics. The negative electrodes were compounds of calcium and either aluminum or silicon,the electrolytes were mixtures of calcium chloride and alkali halides, and the positive electrodes were iron sulfide (FeS). These cells generally exhibited high ampere-hour efficiency, good electrode utilization, and a voltage slightly higher than that of comparable lithium cells. 10 figures, 2 tables.

3274 (ANL—76-8, pp B.176-B.188) **Characterization of porous Li—Al alloy electrodes.** Vissers, D.R.; Anderson, K.E. (Argonne National Lab., IL). 1976.

From Battery workshop; Argonne, Illinois, United States of America (USA) (21 Mar 1976).

In Proceedings of the symposium and workshop on advanced battery research and design, March 22—24, 1976.

The effects of electrolyte void fraction (0.2, 0.4, and 0.7), electrode thickness (0.3 and 0.6 cm), and the type of current collector on the performance of porous Li—Al electrodes were investigated. The results of these studies, which were conducted at approximately 425°C, were as follows: At moderate current densities (approximately 100 mA/cm²), the lithium utilization (fraction of the theoretical capacity of the Li—Al electrode) decreased markedly as the electrode thickness was increased from 0.32 to 0.64 cm. The capacity densities of the 0.32-cm- and 0.64-cm-thick electrodes were higher with 0.2 volume fraction of the electrolyte than with a higher volume fraction of 0.7. The Li—Al electrode performance was apparently limited by resistive polarization associated with the electrolyte, and with particle-to-particle contact of the Li—Al within the porous structure. The addition of a porous metal current collector greatly improved the performance of the 0.64-cm-thick Li—Al electrode. 13 figures.

3275 Gas recombination lead—acid batteries. Mahato, B.K.; Laird, E.C. (Globe-Union Inc., Milwaukee). pp 23-41 of In Power sources 5. Collins, D.H. (ed.). New York; Academic Press Inc. (1975).

From 9. international power sources symposium; Brighton, UK (17 Sep 1974).

See CONF-740908—.

The design of a structurally controlled sealed lead—acid cell has been defined in terms of parametric correlations and its preparation procedures are outlined. The ability to scale up by means of the developed correlations has been demonstrated by preparation and test of 0.9, 7.5, and 47.5 A h cells. These test units have exhibited continuous constant current overcharge capability at rates up to C/20 and cycle life characteristics similar to sealed nickel—cadmium batteries. The internal pressure of these test units remained less than 30 N/cm². Positive grid corrosion appears to be the main failure mode.

3276 Battery charging at low temperature. Willihnganz, E. pp 43-53 of In Power sources 5. Collins, D.H. (ed.). New York; Academic Press Inc. (1975).

From 9. international power sources symposium; Brighton, UK (17 Sep 1974).

See CONF-740908—.

Charge acceptance of a lead—acid battery at -40°F may be limited by either the positive or the negative plates. In the negative, it is the slow solution rate of lead sulfate which controls. A tenfold increase in charge acceptance occurred when an organic expander was purified. In the positive plate, the charge product produces a high counter-e.m.f. which stops charge at the usual voltage. At a higher voltage, better acceptance occurs over a limited range, but the charge product is not lead dioxide, and its usefulness under practical conditions has not been worked out.

3277 Fast charging of sealed nickel—cadmium batteries: theory and practice. Hodge, B.J.R. (SAFT, Ltd., Hampton, Eng.). pp 211-231 of In Power sources 5. Collins, D.H. (ed.). New York; Academic Press Inc. (1975).

From 9. international power sources symposium; Brighton, UK (17 Sep 1974).

See CONF-740908—.

The electrical, electrochemical and physical behavior of sealed nickel—cadmium cells during fast charge are examined. Various existing charge control systems are re-examined, and two new systems are described, one a simple system for use at normal temperatures, the other suitable for a wide temperature range (—20°C to +50°C). Life, reliability, fading and charging efficiency at high temperature are all improved by fast charging, and the results of a study in depth over a wide temperature range are presented. Pulse charging is also studied, and reasons are given to support the finding that the longer the pulse, the more efficient the charge.

3278 Ni—H_2 performance versus Ni—Cd. Font, S.; Goualard, J. (Societe des Accumulateurs, Romainville, France). pp 331-346 of In Power sources 5. Collins, D.H. (ed.). New York; Academic Press Inc. (1975).

From 9. international power sources symposium; Brighton, UK (17 Sep 1974).

See CONF-740908—.

A Ni—H_2 sealed system with an energy density of 60 W h/kg is especially attractive for space applications where a high energy to weight ratio and reliability are of major concern and compares favorably to Ni—Cd. Ni—H_2 construction parameters are presented as well as experimental data covering electrical characteristics, charge retention and cycling performances. Main differences from the Ni—Cd system are attributed to the negative hydrogen electrode characteristics. The poor charge retention of Ni—H_2 seems to depend on H_2 pressure and the activity of the negative electrode catalyst. Ni—H_2 and Ni—Cd cells cycled on the same basis, i.e. 8 h cycle duration at 22°C and 72 percent D.O.D., have already achieved over 1000 cycles.

3279 Polarization and corrosion experiments on sodium—sulphur cells. Bones, R.J.; Brook, R.J.; Markin, T.L. (Atomic Energy Research Establishment, Harwell, Eng.). pp 539-557 of In Power sources 5. Collins, D.H. (ed.). New York; Academic Press Inc. (1975).

From 9. international power sources symposium; Brighton, UK (17 Sep 1974).

See CONF-740908—.

A current interruption device employing a Tektronix 543B oscilloscope to trigger a relay has been used to separate the resistive (IR) voltage losses and polarization voltage losses during charge and discharge of sodium—sulphur cells based on β-alumina electrolytes. Polarization voltage losses have been shown to depend on the state of charge of the cells as well as on current density. Polarization losses on discharge are higher when the sulphur compartment of the battery contains a single phase polysulphide with a

composition between Na_2S_3 and Na_2S_5 than when the sulphur compartment contains a two phase mixture of Na_2S_5 and sulphur. The reverse is true on charge. The causes of the polarization voltage losses are discussed. Corrosion of the stainless steel outer casing/current collector has been investigated. The bright metallic surface seen on some stainless steel current collectors has been shown to occur during the final stages of discharge of the cell and is due to polarization of the melt resulting in the formation of Na_2S_2 close to the steel. The extent of the polarization depends on the graphite felt/steel contact and the current density.

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 3260, 3261, 3277

3280 (ANL—76-8, pp B.2-B.12) **Structural, thermodynamic, and kinetic properties of solid electrodes.** Worrell, W.L.; Nagelberg, A.S. (Univ. of Pennsylvania, Philadelphia). 1976.

From Battery workshop; Argonne, Illinois, United States of America (USA) (21 Mar 1976).

In Proceedings of the symposium and workshop on advanced battery research and design, March 22—24, 1976.

One major impediment to the development of useful reversible batteries is the lack of suitable solid electrode materials. After a brief review of electrochemical principles, the characteristics of an ideal solid electrode are summarized. Solid compounds which appear to possess many of these characteristics are the alkali metal intercalated dichalcogenides of the Group IV and V transition metals. The preparation and crystal structures of these intercalated compounds are reviewed. A method for estimating maximum values of the alkali metal chemical potential in these compounds is described. Knowledge of the compositional variation of the chemical potential and diffusivity of the alkali metal in these compounds is necessary to assess quantitatively their usefulness as cathode materials. Electrochemical cell techniques which can be used to obtain such data are briefly summarized. 4 figures, 4 tables.

3281 (ANL—76-8, pp B.13-B.24) **Substructure and properties of sodium beta alumina solid electrolytes.** De Jonghe, L.C.; Hsieh, M.Y. (Cornell Univ., Ithaca, NY). 1976.

From Battery workshop; Argonne, Illinois, United States of America (USA) (21 Mar 1976).

In Proceedings of the symposium and workshop on advanced battery research and design, March 22—24, 1976.

The microstructure and properties of sodium beta alumina solid electrolytes are discussed. Improved sinterability of commercial beta alumina powder was achieved by addition of small amounts of the $Na_2O—Al_2O_3$ eutectic. Complex crystallographic faults and subgrain boundaries were found that can affect the microscopic homogeneity of the ionic current flow during d.c. ionic conduction. The effects of CaO and SiO_2 additions on microstructure and ionic conductivity are described. 10 figures.

3282 (ANL—76-8, pp B.25-B.40) **Optimization of MgO-doped β-Al_2O_3 with respect to electrical conductivity.** Haar, W.; Fischer, W.; Kleinschmager, H.; Weddigen, G. (Brown, Boveri and Cie, Mannheim, Ger.). 1976.

From Battery workshop; Argonne, Illinois, United States of America (USA) (21 Mar 1976).

In Proceedings of the symposium and workshop on advanced battery research and design, March 22—24, 1976.

The composition of MgO-stabilized β-alumina was varied in the following ranges: 7.3 ... 9.3 weight-% Na_2O, 1 ... 4 weight-% Na_2O, 86.7 ... 91.7 weight-% Al_2O_3. Rod-shaped specimens were prepared from calcined and ballmilled powder, isostatically pressed and sintered at temperatures between 1550 and 1800°C. A four-electrode method was applied to measure the electrical conductivity in the frequency range 100 Hz to 100 kHz by using painted graphite electrodes contacted to platinum foils. Both the conductivity and the β''-Al_2O_3 content increased with increasing Na_2O content. Furthermore, at a constant Na_2O concentration the conductivity reaches a maximum at a certain MgO content depending on the Na_2O concentration. Conductivity values up to 0.3^{-1} $(\Omega cm)^{-1}$ at 300°C were obtained. Some preliminary results of lifetime tests are given. 15 figures, 1 table.

3283 (ANL—76-8, pp B.41-B.49) **Separators for lithium alloy—iron sulfide fused salt batteries.** Walker, R.D. Jr. (Univ. of Florida, Gainesville); Cheng, C.C.; Battles, J.E.; Mathers, J.P. 1976.

From Battery workshop; Argonne, Illinois, United States of America (USA) (21 Mar 1976).

In Proceedings of the symposium and workshop on advanced battery research and design, March 22—24, 1976.

Separators woven from boron nitride roving are reasonably satisfactory for these batteries, but they are expensive and somewhat limited as to their mechanical and electrical characteristics. Paper-like separators can be made from BN, Y_2O_3, or $LiAlO_2$ fibers or their mixtures, but they are very fragile and mechanically unstable. Organic and inorganic binders can overcome some of these limitations, but they generally either react with the anode or they are themally unstable at battery temperatures. The addition of chrysotile asbestos fibers in relatively small proportion increases strength and mechanical stability markedly, but the long-term stability of asbestos in the battery environment is somewhat in question. Preliminary cell tests suggest that the asbestos may disintegrate after a few cycles for reasons which are not clear at present. Strength and other properties can be further improved by adding substantial proportions of powders, such as BN, Y_2O_3, $LiAlO_2$, or MgO, to the fiber mixture. MgO produces very strong sheets but these tend to crack easily. A cell testing program is currently in progress. 2 tables.

3284 (ANL—76-8, pp B.50-B.73) **Materials development in the lithium—aluminum/iron sulfide battery program at Argonne National Laboratory.** Myles, K.M.; Mrazek, F.C.; Smaga, J.A.; Settle, J.L. (Argonne National Lab., IL). 1976.

From Battery workshop; Argonne, Illinois, United States of America (USA) (21 Mar 1976).

In Proceedings of the symposium and workshop on advanced battery research and design, March 22—24, 1976.

The materials development effort in the lithium—aluminum/iron sulfide battery program at the Argonne National Laboratory traverses a spectrum of endeavors that includes design and fabrication, compatibility evaluation, and postoperative examination of various cell components. A brief historical overview of the effort is presented, but emphasis is placed on current areas of activity, with a mention of anticipated future plans. The major topics discussed are the development of electrical feedthroughs, the compatibility of negative- and positive-electrode components with the cell environment, the use of the postoperative examination as an aid in cell design, the study of the Li—Al phase diagram, and the development of positive-electrode current collectors. 10 figures, 5 tables.

3285 (ANL—76-8, pp B.74-B.84) **Wettability of high-temperature cell separators by molten salt.** Eberhart, J.G. (Argonne National Lab., IL). 1976.

From Battery workshop; Argonne, Illinois, United States of America (USA) (21 Mar 1976).

In Proceedings of the symposium and workshop on advanced battery research and design, March 22—24, 1976.

In lithium—aluminum/iron sulfide cells, the ceramic separator and particle retainer materials must be wet and penetrated by the molten LiCl—KCl electrolyte so that lithium ions can easily pass through these porous materials during discharge and charge. Measurements were made of the wettability of solid surfaces of these materials. Molten-salt contact angles were observed to be nonwetting while advancing and wetting while receding. The hysteresis was quite large. Determinations were also made of the molten salt penetrability of various fabrics and papers composed of these materials. These studies suggested procedures which assure salt penetration and permeation through the materials that are difficult to wet. 6 figures, 1 table.

3286 (ANL—76-8, pp B.99-B.116) **Overcharge studies of the FeS_2 electrode in Li/FeS_2 cells.** Tomczuk, Z.; Hollins, R.E.; Steunenberg, R.K. (Argonne National Lab., IL). 1976.

From Battery workshop; Argonne, Illinois, United States of America (USA) (21 Mar 1976).

In Proceedings of the symposium and workshop on advanced battery research and design, March 22—24, 1976.

The overcharge reaction of the FeS_2 electrode in Li/FeS_2 cells was studied by operating five cells to successively higher charge cutoff voltages and also by cyclic voltammetry. The results indicated that increasing the charge cutoff voltage increases the porosity in the FeS_2 electrode while decreasing the coulombic efficiency. The products of the overcharge were identified as ferrous chloride and sulfur. The cyclic voltammetry results indicated that the reaction is irreversible and diffusion-limited. A reduction mechanism consistent with experimental data is proposed. 8 figures, 4 tables.

3287 (ANL—76-8, pp B.117-B.137) **Review of the kinetics of the sulfur electrode in molten sodium polysulfide.** Ludwig, F.A. (Ford Motor Co., Dearborn, MI). 1976.

From Battery workshop; Argonne, Illinois, United States of America (USA) (21 Mar 1976).

In Proceedings of the symposium and workshop on advanced battery research and design, March 22—24, 1976.

The electrode kinetics of the sulfur electrode in a pure melt of a salt of the redox system was investigated in connection with the development of the sodium—sulfur battery. It was found that a

Na_2S_4 melt consists primarily of Na^+ and S_4^{--} ions, that the entire anion concentration is electroactive, that S_2^{--} ion is the product of reduction at the electrode, and that there is no chemical reaction prior to this charge transfer reaction. It is also shown that the usual electroanalytical equations for diffusion control are obeyed within a few percent, with experimental errors within a few percent. The salient feature of all voltage sweep diagrams is a clear distinction between the S/S^{--}/sub x/, the S^{--}/sub x//S_2^{--}, and the S^{--}/sub x//S^{--} reactions. In addition, the diagrams always show a final rise of current at large polarizations. Cathodically, this rise represents the deposition of Na. The final rise on the anodic side most probably indicates that it is sulfur that is oxidized to positive S ions. 14 figures, 1 table. (RWR)

3288 (ANL—76-8, pp B.152-B.153) **Cathode systems for aluminum—molten chloroaluminate batteries.** Mamantov, G.; Marassi, R.; Chambers, J.Q. (Univ. of Tennessee, Knoxville). 1976.

From Battery workshop; Argonne, Illinois, United States of America (USA) (21 Mar 1976).

In Proceedings of the symposium and workshop on advanced battery research and design, March 22—24, 1976.

The electrochemical characterization of several potential cathode systems for batteries using low-melting-point (less than 200°C) molten chloroaluminate ($AlCl_3$—NaCl mixtures) solvents was investigated. These melts offer several advantages for molten salt battery applications. The following potential cathode systems in these melts were studied: fluorinated graphite with different F content (CF/sub 0.85—1/), binary and ternary intercalation compounds (e.g. C—WCl_6 and C—$AlCl_3$—Cl), several quinones, and positive iodine and sulfur cations. The latter was the most promising. The electrochemical behavior of S and sulfide in molten $NaAlCl_4$ saturated with NaCl was investigated at different temperatures and with different electrode materials. The mechanism for the electrochemical oxidation of S apparently involves a complex set of charge transfer and chemical steps. (RWR)

3289 (ANL—76-8, pp B.154-B.166) **Studies on the negative alloy electrode.** Ito, Y.; Matsunaga, M.; Yoshizawa, S. (Kyoto Univ., Sakyo, Japan). 1976.

From Battery workshop; Argonne, Illinois, United States of America (USA) (21 Mar 1976).

In Proceedings of the symposium and workshop on advanced battery research and design, March 22—24, 1976.

Alkali metal alloy is a promising negative electrode for a high-performance battery. Energy density and power density of such alloy electrodes can be discussed in relation to the phase diagram. Liquid alloy is preferable when cycle life is exaggerated, and solid alloy is preferable from the cell design aspect. Experimental data to support such conclusions are shown in this paper. 15 figures, 3 tables.

3290 (ANL—76-8, pp B.167-B.175) **Lithium—silicon electrodes for the lithium—iron sulfide battery.** McCoy, L.R.; Lai, S. (Rockwell International, Canoga Park, CA). 1976.

From Battery workshop; Argonne, Illinois, United States of America (USA) (21 Mar 1976).

In Proceedings of the symposium and workshop on advanced battery research and design, March 22—24, 1976.

Lithium—silicon negative electrodes are being developed at Atomics Internatonal for use in high-temperature (400°C) lithium—iron sulfide load-leveling batteries. These electrodes discharge in a series of voltage plateaus with an average open-circuit potential of 230 mV positive to lithium. Four alloy compositions, solid at temperatures below approximately 600°C, were identified. Thermodynamic data for the formation of each composition was calculated. Light-weight structures providing current collection as well as support and containment for the alloys were found. These electrodes have specific capacities in excess of 0.80 Ah/cm³, and 80 percent or more utilization of the theoretical capacity of the active materials was obtained at current densities (40 mA/cm²) of interest to load-leveling service with electrodes 0.64 cm thick. Optimization studies are being made to determine the effect of structural variables and specific capacity loading on electrode performance. 4 figures, 3 tables.

3291 (ANL—76-8, pp B.189-B.198) **Studies on the bipolar liquid metal electrode.** Ito, Y.; Goto, M.; Yoshizawa, S. (Kyoto Univ., Sakyo, Japan). 1976.

From Battery workshop; Argonne, Illinois, United States of America (USA) (21 Mar 1976).

In Proceedings of the symposium and workshop on advanced battery research and design, March 22—24, 1976.

This paper concerns a new cell design, in which a liquid layer acts as a bipolar electrode and as a current conducting path. In a molten salt battery system, increase of current efficiency and decrease of ohmic loss are usually contradictory; but, if a liquid metal layer is used, as an intermediate current path, these factors are not in conflict any more. The principle of this method and experimental results are discussed in detail. 16 figures, 2 tables.

3292 (ANL—76-8, pp B.199-B.209) **Performance of shaped graphite electrodes in sodium sulfur cells.** Minck, R.W. (Ford Motor Co., Dearborn, MI). 1976.

From Battery workshop; Argonne, Illinois, United States of America (USA) (21 Mar 1976).

In Proceedings of the symposium and workshop on advanced battery research and design, March 22—24, 1976.

Results obtained on testing a series of cells which incorporated differently shaped graphite electrodes are presented. The results are interpreted in terms of mass transport processes. The geometry of the electrode strongly influences cell performance. Generally, geometric changes enhance discharge performance at the expense of charge performance, or vice versa. In contrast, changes in operating temperature affect both charge and discharge performance similarly. 11 figures.

3293 (ANL—76-8, pp B.231-B.238) **Mechanical seal for the sodium/sulfur cell.** Tilley, A.R. (British Railways Board, Derby, Eng.). 1976.

From Battery workshop; Argonne, Illinois, United States of America (USA) (21 Mar 1976).

In Proceedings of the symposium and workshop on advanced battery research and design, March 22—24, 1976.

The development of a suitable sealing method is one of the technical problems that has to be solved before the high-temperature sodium/sulfur battery becomes a commercial reality. This paper describes the development of a potentially low-cost, lightweight seal assembly that is suitable for operation at 350°C. The results of stress analysis, seal, leak tests, and cell cycling studies are described. 3 figures, 2 tables.

3294 (ANL—76-8, pp B.277-B.292) **Considerations in the use of electrical measurement techniques to evaluate potential new electrolytes and mixed conductors.** Raistrick, I.D.; Huggins, R.A. (Stanford Univ., CA). 1976.

From Battery workshop; Argonne, Illinois, United States of America (USA) (21 Mar 1976).

In Proceedings of the symposium and workshop on advanced battery research and design, March 22—24, 1976.

Exploratory efforts are being undertaken in a number of laboratories to identify and evaluate the properties of new solid electrolytes and mixed conductors because of their potential use in such applications as high-performance batteries and fuel cells. Due to large values of ionic mobility in such materials, particular care must be exercised either to avoid or to compensate for interfacial polarization effects. Methods for experimental determination of the important parameters in such cases are reviewed, with emphasis upon the interpretation of frequency-dependent ac measurements. 12 figures.

3295 (LBL—5186) **Engineering evaluation of solid transition-metal sulfide electrodes for use in high energy-density batteries.** Marmaduke, B.A.; Donaghey, L.F. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jun 1976. Contract W-7405-ENG-48. 5p. (CONF-760906—19). Dep. NTIS $3.50.

From 11. intersociety energy conversion engineering conference; State Line, Nevada, United States of America (USA) (12 Sep 1976).

Solid electrode materials exhibiting anomalously high alkali ion diffusivities through layered structures were studied for application in high-energy-density, fast-discharge-rate batteries. The maximum storage capacity and maximum discharge rates were studied theoretically for a spectrum of transition metal sulfides which crystallize in the CdI_2 and MoS_2 structures. Simple criteria were established for screening potentially important solid electrode materials for battery applications. 1 figure, 4 tables.

3296 **Electrochemical behavior of the lead dioxide electrode.** Pohl, J.P.; Rickert, H. (Univ., Dortmund, Ger.). pp 15-22 of In Power sources 5. Collins, D.H. (ed.). New York; Academic Press Inc. (1975).

From 9. international power sources symposium; Brighton, UK (17 Sep 1974).

See CONF-740908—.

The PbO_2 electrode is treated from the thermodynamic and kinetic point of view as a nonstoichiometric oxide electrode. It is shown that at least two partial currents have to be considered, that of lead ions and that of oxygen ions. During anodic polarization of a PbO_2 electrode, initially lead is dissolved and oxygen deposited, resulting in a change of stoichiometry of the lead dioxide. During cathodic polarization the opposite is the case. Only these deviations of the stoichiometry make it possible that under stationary state conditions lead and oxygen are dissolved or deposited in the absolute ratio 1 : 2 according to the stoichiometric formula.

3297 Kinetics of the $PbSO_4/PbO_2$ electrode at low temperatures. Vareriote, E.M.L.; Gallop, L.D. (Defence Research Establishment, Ottawa). pp 55-71 of In Power sources 5. Collins, D.H. (ed.). New York; Academic Press Inc. (1975).

From 9. international power sources symposium; Brighton, UK (17 Sep 1974).

See CONF-740908—.

Direct and alternating current potentiostatic and potentiodynamic measurements were applied to the study of lead dioxide formation in sulphuric acid at temperatures from -50°C to 0°C. The initial oxidation reaction kinetics were found to be controlled by two-dimensional nucleation and growth, followed by diffusion through the completed surface layer. From the model and derived results, the heights of the nuclei were determined as a function of temperature and applied potential, and from both the linear scan voltammetry and potential-step methods the diffusion parameters of the rate controlling step were obtained. These results permit an improved description of the sequential anodic oxidation processes.

3298 Effects of metallurgical structure on hydrogen evolution on lead alloys. Caldwell, T.W.; Sokolov, U.S. (NL Industries, Hightstown, NJ). pp 73-95 of In Power sources 5. Collins, D.H. (ed.). New York; Academic Press Inc. (1975).

From 9. international power sources symposium; Brighton, UK (17 Sep 1974).

See CONF-740908—.

The rate of hydrogen evolution at constant composition on Pb—Sb, Pb—Ca, and Pb—Ca—Sn alloys was determined as a function of solidification parameters and hence of the microstructure. In all cases the rate of gassing decreased with increasing cooling rate. Heat treatments were employed to separate the influence of individual microstructural features. The relationships between solidification conditions and microstructure and between over-voltage and microstructure are discussed. The effect is believed to be of a general nature applying to other alloy systems as well as to other electrode reactions.

3299 New battery state-of-charge indicator especially for use in electric vehicles. Bader, C. (Deutsche Automobilgesellschaft mbH, Esslingen, Ger.). pp 155-165 of In Power sources 5. Collins, D.H. (ed.). New York; Academic Press Inc. (1975).

From 9. international power sources symposium; Brighton, UK (17 Sep 1974).

See CONF-740908—.

To indicate the available energy supply of electrochemical storage batteries, a measuring unit has been developed which indicates the behavior of the energy source during charging and discharging by simulating the essential physical characteristics, for which purpose the unit employs measurable quantities such as voltage, current and the temperature of the energy source. The numerical data of the simulated functions refer to a lead—acid battery, but the unit can be equally well employed for other types of batteries by changing coefficients appropriately.

3300 Investigations into the mechanism of capacity loss by porous cadmium electrodes during cycling. Barnard, R.; Lee, J.A.; Rafinski, A.H.; Tye, R.L. (Every Ready Co., Ltd., London). pp 183-209 of In Power sources 5. Collins, D.H. (ed.). New York; Academic Press Inc. (1975).

From 9. international power sources symposium; Brighton, UK (17 Sep 1974).

See CONF-740908—.

Loss of capacity of porous cadmium electrodes during cycling is confirmed. Chemical analysis establishes that the substantial losses experienced in early cycling are due both to the presence of residual cadmium after discharge and residual $Cd(OH)_2$ after charge, with the former being the major effect. The rate of loss decreases with charge rate but, revealingly, is independent of discharge rate. The techniques of linear sweep voltammetry and microscopy show that, on cycling, cadmium migrates toward the outer surfaces of the electrode and increases considerably in crystallite size. The failure mode proposed is coverage of cadmium surface by precipitated $Cd(OH)_2$ which induces passivation by a solid-state mechanism. The increase of residual cadmium on cycling is due to the increased cadmium crystallite size yielding less area to be blocked and to the confinement of cadmium to a smaller volume making blocking of the surface more probable.

3301 New type of inorganic separator for alkaline silver batteries. Jonville, P. (Battelle, Geneva); Fresnel, J.M.; Bezaudun, J. pp 233-259 of In Power sources 5. Collins, D.H. (ed.). New York; Academic Press Inc. (1975).

From 9. international power sources symposium; Brighton, UK (17 Sep 1974).

See CONF-740908—.

In alkaline batteries containing a silver electrode, breakdown occurs mostly because of unsuitable separators which are not sufficiently resistant to the strong oxidizing power of silver oxides. In order to overcome this drawback, a new type of inorganic separator for alkaline silver cells has been developed. This separator is prepared by directly plasma spraying a molten refractory oxide, such as zirconia, on the silver electrode. The porous layer obtained by this technique is closely adherent to the silver substrate, the structure of which has been particularly adapted to this purpose. Moreover, this membrane is chemically inert in potassium hydroxide solution and does not undergo any attack by silver oxide. The layers of zirconia are characterized by a high microporosity combined with a rather high tortuosity factor. The porosity, the specific resistivity in KOH and also the rate of silver transport through these layers have been determined as a function of the manufacturing parameters. Their ability to cut down the migration of silver from the positive to the negative electrode was measured in silver—cadmium cells and compared with that of Cellophane separators. The new inorganic separators give silver batteries a considerably increased lifetime due to greatly reduced deposition of metallic silver on the Cellophane separator, as a result of which the time before cell failure occurs by internal short-circuit increases.

3302 Secondary cells based on reversible hydrogen transfer between electrodes capable of absorbing large volumes of hydrogen in interstitial solid solutions. Lewis, F.A.; Witherspoon, M.C.; Obermann, A. (Queen's Univ., Belfast). pp 361-369 of In Power sources 5. Collins, D.H. (ed.). New York; Academic Press Inc. (1975).

From 9. international power sources symposium; Brighton, UK (17 Sep 1974).

See CONF-740908—.

Several transition metals and their alloys absorb large volumes of hydrogen accompanied by formation of distinct hydride phases. These solids can retain a considerable measure of the electrical conductivity and cohesiveness of the metal: they are also characterized by a high internal hydrogen mobility. Over the range of hydrogen contents of phase transformations the virtually constant chemical potential of hydrogen is reflected by corresponding characteristic values of electrode potential. Pairs of electrodes with differing phase transformation potentials can constitute cells for which the sole overall chemical reaction during either charge or discharge can be the transfer of hydrogen from one electrode to the other.

3303 Magnesium alloys for anodes in alkaline-electrolyte power sources. Wiesener, K.; Glaeser, W.; Pelz, R. (Technische Univ., Dresden). pp 425-446 of In Power sources 5. Collins, D.H. (ed.). New York; Academic Press Inc. (1975).

From 9. international power sources symposium; Brighton, UK (17 Sep 1974).

See CONF-740908—.

In our laboratory, tests were made on magnesium and magnesium alloys as to their qualifications for metal—air elements with alkaline electrolytes. Magnesium was alloyed with aluminium, zinc, lead, thallium, mercury and lithium. As the electrolyte, a 5 M $NaClO_4$ solution was used to which varying amounts of NaOH were added. Various methods of measurement and analysis methods were used for the characterization of the anode materials employed: 1. Galvanostatic measurements; 2. Delta voltage method; 3. Determination of the corrosion rates before, during and after electrochemical loading; and 4. Examination of complete metal—air cells.

3304 Anodic behaviour of indium and indium/bismuth alloys in alkaline solutions. Armstrong, R.D.; Dickinson, T.; MacFarlane, B.; Thirsk, H.R. (Univ. of Newcastle upon Tyne, Eng.). pp 479-502 of In Power sources 5. Collins, D.H. (ed.). New York; Academic Press Inc. (1975).

From 9. international power sources symposium; Brighton, UK (17 Sep 1974).

See CONF-740908—.

In KOH and NaOH solutions, indium undergoes anodic dissolution at potentials more positive than -1.16 V. The Tafel slope for this process is about 26 mV/decade and the order of reaction with respect to hydroxide ion is 3. A mechanism for this reaction is proposed. Three types of passivating layer are produced; in the sequence $In(OH)_3$, InOOH and In_2O_3 at progressively more positive potentials. The first layer is porous and not very protective but In_2O_3 is highly protective and difficult to reduce. The presence of bismuth reduces the passivating properties of these layers and especially those of In_2O_3.

3305 Sulphate based solid electrolytes with some applications. Heed, B.; Lunden, A. (Chalmers Univ. of Tech., Gothenburg, Sweden). pp 573-579 of In Power sources 5. Collins, D.H. (ed.). New York; Academic Press Inc. (1975).

From 9. international power sources symposium; Brighton, UK (17 Sep 1974).

See CONF-740908—.

There exist a number of systems with sulphate as the sole or main anion in which cations have a high mobility. For binary sulphate systems highly conducting phases can be found down to at least 415°C. If additional components are added conductivities exceeding 10^{-3} Ω cm^{-1} can be obtained at ambient temperatures. A $Mg/Li_{1.72}Mg_{0.14}SO_4/MnO_2$ cell gave an open-circuit cell voltage of 2.5 V and a power density of 0.3 W/cm^3 at 650°C. At ambient temperatures Ag/electrolyte/I_2 cells can be run in air without any precautions to remove moisture. Although the conductivity is much less than for $RbAg_4I_5$, the current-voltage curves obtained seem to be comparable with curves reported for $RbAg_4I_5$ cells.

3306 Scanning electron microscopic studies of lithium and cycle behavior of lithium nonaqueous cells with transition metal chalcogenide cathodes. Broadhead, J.; Trumbore, F.A. (Bell Labs., Murray Hill, NJ). pp 661-682 of In Power sources 5. Collins, D.H. (ed.). New York; Academic Press Inc. (1975).

From 9. international power sources symposium; Brighton, UK (17 Sep 1974).

See CONF-740908—.

Rechargeability studies of cells employing cathodes of $NbSe_3$, NbS_3, $TaSe_3$, and TiS_3 in 1 M $LiClO_4$ in propylene carbonate are discussed. All systems show rechargeability and, with the exception of TiS_3, cell failures are related to lithium anode morphology changes. Preliminary scanning electron micrographs of lithium electrodes are presented together with associated chronopotentiograms of lithium electrodeposition on metal substrates. On cycle, with selected electrolytes, completely smooth surfaces of lithium are observed for several cycles while 10 cycles densely packed crystalline lithium is observed. Cycle experiments with lithium anodes in contact with 0.6 M tetrabutylammonium iodide in 1.0 M lithium perchlorate in propylene carbonate exhibited 130 cycles at approximately 50 percent depth of cathode discharge compared with about 90 cycles at 25 percent depth of discharge when 1 M lithium perchlorate in propylene carbonate was used as electrolyte.

APPLICATIONS

REFER ALSO TO CITATION(S) 3256, 3257, 3272, 3299, 3395

3307 (ANL—76-8, pp A.2-A.18) **Secondary batteries for load leveling.** Birk, J.R.; Kalhammer, F.R. (Electric Power Research Inst., Palo Alto, CA). 1976.

From Battery workshop; Argonne, Illinois, United States of America (USA) (21 Mar 1976).

In Proceedings of the symposium and workshop on advanced battery research and design, March 22—24, 1976.

More than fifty years ago, secondary batteries were used advantageously to store and deliver electric energy for electric rail and city emergency power systems. Today, batteries are being considered seriously for storage of off-peak energy because they promise a possibly unique combination of favorable operational characteristics, flexible siting, and environmental compatibility. These prospects have given rise to broad and growing activities in research, development, and engineering of advanced battery concepts and systems for utility energy storage. The technical and cost criteria for utility energy storage are briefly discussed here. Candidate battery systems are reviewed in terms of their characteristics and basic prospects to meet utility criteria. The question of the technoeconomic feasibility of lead—acid batteries for utility energy storage is also examined. Significant technical and economic obstacles on the way to practical utility batteries are identified and related to the major ongoing development efforts. 3 figures, 5 tables.

3308 (ANL—76-8, pp A.19-A.33) **Secondary batteries for electric vehicles.** Landgrebe, A.R. (Energy Research and Development Administration, Washington, DC). 1976.

From Battery workshop; Argonne, Illinois, United States of America (USA) (21 Mar 1976).

In Proceedings of the symposium and workshop on advanced battery research and design, March 22—24, 1976.

An important part of the Energy Storage Program of the U. S. Energy Research and Development Administration is the development of secondary storage batteries for automotive propulsion applications. The successful development of batteries for this purpose will provide significant savings of oil resource and will also have beneficial environmental effects. Of the battery systems being developed, major efforts are presently or will be concentrated on the following seven systems: advanced lead—acid, nickel—iron, nickel—zinc, zinc—air, iron—air, lithium—metal sulfide, and sodium—sulfur batteries. The probability that one or more of these systems will meet the technical requirements for the intended application within the next several years appears good. The ultimate technical/economic feasibility of these systems cannot be assessed at this time because many engineering problems must still be resolved. However, the high-temperature systems, Li—MS and Na—S systems, appear to be good candidates for electric vehicles in the long term. 7 tables.

3309 (ANL—76-8, pp A.107-A.128) **Battery development in Japan.** Yao, N.P. (Argonne National Lab., IL). 1976.

From Battery workshop; Argonne, Illinois, United States of America (USA) (21 Mar 1976).

In Proceedings of the symposium and workshop on advanced battery research and design, March 22—24, 1976.

The main thrust of battery development in Japan is toward application in electric vehicles. Incentives to develop commercial-scale electric vehicles in Japan are the desires to improve the air and noise quality in big cities, and to secure an international position in the electric vehicle field and thereby expand Japan's economy. Development of advanced battery technology for electric vehicles has been in progress as a part of the National Electric Vehicle Research and Development Project, instituted early in 1971 by the Agency of Industrial Science and Technology, MITI, Japan. Three general types of advanced vehicle batteries are being developed under the national project: lead—acid, metal/air, and sodium/sulfur. Progress has been made in each of the advanced batteries since 1971. Battery performance goals established for 1977, which marks the conclusion of the national project, incorporate an increase of cycle life requirement with reduced specific energy goals. Performance demonstration of the advanced batteries in experimental electric vehicles is expected early in 1977. 12 figures, 4 tables.

ENERGY MANAGEMENT AND POLICY

REFER ALSO TO CITATION(S) 3375

SYSTEMS STUDIES AND TOTAL ENERGY

3310 (AED-CONF—75-617-001) **Decisions on the way to the future energy market.** Schulten, R. (Technische Hochschule Aachen (Germany, F.R.). Lehrstuhl fuer Reaktortechnik). 1975. 12p. (In German). (CONF-7510134—1). INIS.

From Association meeting of the Verband Kommunaler Unternehmen e.V.; Duesseldorf, German, Federal Republic of (F.R. Germany) (21 Oct 1975).

5 figs. Available from ZAED.

The transition to new energy systems and, in this connection, the obligatory restructuring of the energy market, will take at last 30 years since completely new techniques will have to be developed. The energy demand is at present on the increase and will be saturated in about 80 years' time. Recommendations regarding the primary energies to be used in the FRG in the future are to the effect that the import of liquid fossil fuels should be decreased and the money thus saved be spent on further developing the use of nuclear energy combined with inland coal and on the creation of new jobs resulting from this. New energy systems to be considered are: a) nuclear district heating in the form of chemically bound energy, b) coal gasification, c) short-distance supply with hot water, and d) the release of the secondary energy carrier hydrogen by means of the at present still hypothetical thermolysis of water. The real problems resulting from the use of nuclear energy are waste disposal, nuclear fusion, and nuclear fuel supply. Some energy centers located over the whole of the FRG could be in a position to solve these problems in an optimal way. The article ends by going into the question of when a new energy system will be introduced.

ECONOMICS AND SOCIOLOGY

REFER ALSO TO CITATION(S) 3071, 3333, 3339

3311 Model for understanding the relationships of money, energy, and survival value. Odum, H.T.; Bayley, S. pp 345-360 of In Economics and decision making for environmental quality. Conner, J.R. (ed.). Gainesville, FL; Univ. of Florida Press (1975).

The quantitative relationships of flows of energy and money are considered with the help of an energy-money unit model, and an analog simulation test is made to indicate its stability. Common

roots of ecological and economic concepts are sought in basic laws of energetics and natural selection. Finally, suggestions are made for energy cost-benefit analysis and for stabilizing the economies of man during periods of changing energy basis. (JWP)

ENVIRONMENT, HEALTH, AND SAFETY

REFER ALSO TO CITATION(S) 2335, 2336, 2337, 2628, 3311, 3316, 3341, 3387, 3803, 3822, 3823, 3824, 3830, 3831, 3832, 3833, 3878, 3879, 3880, 3881, 3894

3312 (ERDA—76-29) **Environmental research and the ERDA fossil energy research centers: a recommended complementary program. Interim report.** (Greenfield, Attaway and Tyler, Inc., San Rafael, Calif. (USA)). 31 Oct 1975. 198p. Dep. NTIS $7.50.

When the U.S. Bureau of Mines Energy Research Centers were assigned to the U. S. Energy Research and Development Administration, the Division of Biomedical and Environmental Research had a consulting firm survey their facilities, experience, and staffs. A program was recommended to complement other government environmental and occupational programs related to energy production and usage, covering the division's responsibilities, and relating to new processes (such as coal conversion) being developed by the Energy Research Centers and others. The program aims at an early assessment of the environmental effects (public and occupational health effects and non-health aspects) of the various processes and timely interaction to evaluate any changes in effluent characteristics and operational variations and to make the developers aware of possible hazards. The program will incorporate identified capabilities at the Energy Research Centers into the established Division program in these areas. The recommended program is described as follows: technical approach; short, intermediate and long term problems; and management of the complex, interdisciplinary program. In appendices, the various processes are described briefly, with identification of possible toxic materials and carcinogens. (LTN)

3313 **Stacks vs. scrubbers.** Yeager, K.E. pp 2-16 of In Fossil Fuel and Advanced Systems Division. Progress report for the period ending July 1975. Palo Alto, CA; Electric Power Research Institute (1975).

A technically feasible national strategy for achieving the established sulfur dioxide (SO_2) ambient air quality standards over the next decade must employ both stacks and scrubbers. Such a strategy is not only the least costly to the nation but the only one consistent with available supplies of domestic fuel and control technology. Characterization of SO_2 control options as stacks and scrubbers is simplistic. Stacks are important elements that reduce emissions by either load or fuel change, or by a combination of both. Ambient air quality may depend on stack height, which influences the dispersal of emissions and their resulting concentration at ground level. Such methods are also called intermittent control systems (ICS). Scrubbers, on the other hand, are process plants for flue-gas desulfurization (FGD), which operate at all times with a defined SO_2 removal efficiency. Such installations are called continuous emission controls. This article attempts to put these SO_2 control technologies into perspective by examining (1) the basis for air quality standards, (2) the capabilities and status of ICS and FGD systems, and (3) an approach to a control strategy that recognizes both the present state of the art in control technology and the unpredictable nature of future air quality criteria.

3314 **Air pollution control for the electric power industry.** Balzhizer, R.E. *Aware;* No. 71, 9-12(Aug 1976).

From "Air quality management in the electric power industry", 12. air pollution and industrial hygiene conference; Austin, TX, USA (28 Jan 1976).

The author concludes that coal will be burned in larger amounts over the balance of the century. Clean fuels from coal will not be produced in significant quantities before 1990. Near-term management of air quality for coal-fired power generation will require less technical elegance than judicious application of proven, cost-effective technology to protect public health. Heavy investments in R and D that identify the real threats to public health and the environment are needed. Technologies need to be developed that control the real problems. Credible emission standards are also needed. Cooperation between government and industry will be required in the identification of real health hazards from power plant emissions and in the short-term application of all available technologies to deal with present air pollution problems. This cooperation will allow time to identify the real problems and develop optimal technology to realize long-term improvements in air quality. (MCW)

3315 **Requests for information: confidentiality of business information.** *Fed. Regist.* (*Wash., D.C.*); **41**: No. 171, 36902(1 Sep 1976).

From Environmental Protection Agency.

Many of the changes to Subpart A are merely matters of style designed to more clearly set forth procedural rules which were stated in the earlier version. Subpart B establishes procedures and substantive rules designed to: limit the likelihood of inadvertent disclosure of confidential business information; afford businesses a fair opportunity both to assert a confidentiality claim and to substantiate the claim prior to an EPA ruling on the claim; allow a business to seek judicial review of an EPA ruling unfavorable to it; protect the interests of members of the public who request disclosure of business information under the Freedom of Information Act, 5 U.S.C. 552; and furnish guidance to EPA officers and employees.

ENERGY RESOURCES

3316 **Minerals and energy from the public lands: an assessment of current conditions. Proceedings of the Rocky Mountain energy-minerals conference held October 15 and 16, 1975 in Billings, Montana.** Billings, MT; Bureau of Land Management (1975). 298p. U.S. Dept. of the Interior, Bureau of Land Management, Billings, Montana.

The conference was directed toward the problems encountered in developing and producing minerals and energy from the public lands. The speakers explored such topics as the availability of minerals, an assessment of our Nation's resources, and the legal constraints and Federal policies affecting production. Following the welcome by E. Zaidlicz, U. S. Bureau of Land Management, papers were presented, entitled: Minerals Management on Public Lands; Producing Energy-Minerals in Montana; Coal and the Public Lands; Nudity is Still Unacceptable; Canada's Mineral Industry—Will It Be Destroyed by Socialist Economic Ideology; Current Land Legislation; Conversion of Resources to Mineral Reserves; Mine Financing—from Bad To Worse; Variations on A Theme Dealing with Conservation; A Mining Industry Viewpoint; Energy Independence—Will We Get There from Here; Energy Minerals—An Assessment of the Current Situation; Energy and the Environment; America's Energy Dilemma—a Failure to Act; and Good and Bad Gambles in the Search for Energy Independence. (MCW)

RESEARCH AND DEVELOPMENT

3317 (NP—21008) **Proposed energy research and development program: fiscal year 1976/77. California Energy Resources Conservation and Development Commission.** (California Energy Resources Conservation and Development Commission, Sacramento (USA)). Feb 1976. 187p. (RD—76-1). TIC.

California's proposed 1976/1977 energy research and development program is a practical, integrated effort designed to be of significant benefit to California over the near and long term. It is aimed at finding, developing, and facilitating the widespread use of economically attractive, alternative energy systems having minimal adverse environmental impact. The results of this program will expand the energy options available to Californians. It will enhance personal, local, and State level control over the energy future. Further it will facilitate innovative, constructive responses on the part of Californians to the rapidly changing nature of the energy problem. ... In particular, this program concentrates on new conservation techniques and alternative energy sources, especially solar and geothermal energy. In addition new options for the siting of the State's energy facilities will be further developed. However, new technologies are only one aspect of what is needed to resolve State energy problems. An equally important aspect involves ensuring the broad application of these new techniques in all regions of California, and the task of promoting rapid market penetration of worthwhile new technologies will be designed into each program and project from the start. The proposed program has been divided into seven program areas: Solar Energy; Geothermal Energy; Conservation and Efficiency; Inter-Program Projects; Fuels; Transportation; and Utility Systems. (from Overview and Summary)

NUCLEAR ENERGY

REFER ALSO TO CITATION(S) 2432, 2437, 2447, 2486, 2504, 2525, 2545, 2826, 2933, 2934, 2949, 2954, 2955, 3071, 3326

3318 Atomic energy: scientific and technical cooperation for peaceful uses. Agreement between the United States of America and the Union of Soviet Socialist Republics signed at Washington, June 21, 1973. pp 54-60 of In Background materials on U.S.—U.S.S.R. cooperative agreements in science and technology. Washington, DC; Congressional Research Service (1975).

Treaties and Other International Acts Series 7655.

This agreement states that, with cooperation between the two countries, solutions to certain nuclear technologies may be solved faster. Article 2 states that cooperation will be concentrated on controlled thermonuclear fusion, fast breeder reactors, and research on the fundamental properties of matter. Other agreements dealing with these areas of cooperation are delineated in six other articles and are to remain in force for ten years. (MCW)

3319 Laser fusion. Isaacson, L.K. pp 17-23 of In Fossil Fuel and Advanced Systems Division. Progress report for the period ending July 1975. Palo Alto, CA; Electric Power Research Institute (1975).

Laser-pellet fusion may be a way to achieve thermonuclear fusion for power generation, but its scientific feasibility is yet to be proved. Major development of the laser-pellet fusion concept in the United States is being pursued primarily at seven different institutions: Lawrence Livermore Laboratory (LLL); Los Alamos Scientific Laboratory (LASL); KMS Fusion, Inc. (KMSF); the University of Rochester; Battelle Memorial Institute, in Columbus; Sandia Laboratory, in Albuquerque (SLA); and the Naval Research Laboratory (NRL); in Washington, D.C. ERDA's time schedule to accomplish its overall laser-fusion program involves the following goals; significant thermonuclear burn in FY77-78, weapons effects simulation (vulnerability) in FY77-78, scientific break-even in FY79-81, weapons physics modeling in FY79-81, weapons lethality effects simulation in FY79-81, and net energy gain in FY81-83. An operating laser-fusion test reactor is projected for the mid-1980s, with a demonstration power reactor to follow by the late 1990s. Programs at the seven U.S. institutions are summarized. (MCW)

3320 Nuclear power: compared to what. Rose, D.J. (Massachusetts Inst. of Tech., Cambridge); Walsh, P.W.; Leskovjan, L.L. *Am. Sci.*; **64**: No. 3, 291-299(1976).

Decisions that will affect electric power generation at about the end of the century are examined. A nuclear power plant decided upon now could be in operation by 1986 and in its mid-life in the year 2000. Oil and gas will be scarce. The real choices will be among nuclear fission (with breeder reactors in prospect), controlled fusion, bulk solar power, and coal. Other prospects that seem limited or too difficult to develop include geothermal, wind power, ocean thermal gradients, and tidal power. The impact of energy conservation is summarized. The main obstacles to substantial conservation as a viable option are the attitudes and personal desires of people and the inadequacy of enforcement by institutions. 31 references. (MCW)

3321 Nuclear fuels supply. New York; Edison Electric Institute (1976). 125p.

This study program was carried out by the EEI Policy Committee on Nuclear Power with assistance from the Tennessee Valley Authority and certain members of the American Public Power Association. The Enrichment and Processing Group of the Japanese Electric Utility Industry became a co-sponsor of the program. Conclusions are: (1) the U.S. is now significantly dependent on nuclear power for generation of electricity; (2) demand for electricity is expected to continue to grow, with nuclear power to make an increasing contribution; (3) nuclear fuels must be supplied in amounts required to sustain the current and prospective demand; (4) assurance of supply of nuclear fuels for the power plants now in operation or committed is generally satisfactory for the short term (1975 to 1980) and less satisfactory but manageable for the near term (1975 to 1985); (5) supply for the longer term (1985-on) depends on the near-term deficiencies being corrected and timely decisions made on long lead-time items; (6) supply operations that should be accorded the highest priority in the near term are uranium exploration, mining and milling, enrichment and spent fuel storage; (7) it is urgent that a nationally acceptable radioactive waste management plan be implemented and reprocessing and recycle of uranium and plutonium be demonstrated; (8) problems of nuclear fuels supply are technically solvable; present difficulties stem principally from the impact of open issues of public policy on regulatory decision making; and (9) utilities should plan to act to: (a) assure a maximum of viable competitive private sector supply operations and (b) more effectively impact on U.S. Government decision making on nuclear fuels supply.

3322 Appendices to the report of the Edison Electric Institute on nuclear fuels supply. New York; Edison Electric Institute (1976). vp.

Nine appendices are included: estimates of demand, supply, financial requirements, and cost and price estimates for major components of the fuel cycle; uranium supply; enrichment services supply; spent fuel temporary storage; spent fuel transportation; reprocessing and recycle of Pu and U; radioactive waste management; HTGR fuel cycle; and impact of LWR fuel performance on fuel cycle planning. (DLC)

3323 Breeder: when and why. Minnick, L.; Murphy, M. *EPRI J.*; **1**: No. 2, 6-11(Mar 1976).

A brief discussion is presented of the uranium fuel cycle and the economic benefits possible from the introduction of the LMFBR. A summary is included of breeder programs and experience in the United Kingdom, France, USSR, West Germany, and Japan. The U.S. breeder program is discussed with emphasis on project organization, which includes both the government and the electric utility industry. (DG)

CONSERVATION

REFER ALSO TO CITATION(S) 2375, 2663, 3320, 3326, 3327, 3328, 3337, 3346, 3347, 3348, 3349, 3350, 3351, 3352, 3353, 3354, 3355, 3356, 3357, 3358, 3835, 4342

3324 Fuel economy regulations and test procedures for 1977 and later model automobiles. *Fed. Regist.* (*Wash., D.C.*); **41**: No. 100, 21002-21019(21 May 1976). (40CFR600).

From Protection of Environment, 40CFR600, Environmental Protection Agency—Fuel economy of motor vehicles.

The most significant issue in the proposed regulations is the method of determining comparability of automobiles to implement the requirement of the Act that fuel economy labels will display the fuel economy range of all comparable automobiles. The Preamble describes two approaches, one utilizing wheel base as a determinate, the other, an interior/exterior size or volume approach, using a combination of interior and exterior volume indices. Comments on a number of subsidiary issues regarding comparability are also requested.

SUPPLY, DEMAND, AND FORECASTING

REFER ALSO TO CITATION(S) 2358, 3310, 3311, 3321, 3322

3325 Forecasting energy use: the residential sector. Boyd, J.W. *EPRI J.*; **1**: No. 3, 6-13(Apr 1976).

The article examines a number of forecasting approaches and is intended to assist in understanding and interpreting the various residential energy demand forecasting models in terms of their assumptions and modeling structures. In the process, the strengths and weaknesses of these models in alternative forecasting applications are discussed. The three alternative models discussed are the Autoregressive Model to forecast annual electricity use; the Appliance Stock Model to forecast annual electricity use, distinguishing between the household short- and long-term demands for energy; and the Aggregate Energy Model, which ignores interfuel substitution possibilities and frequently produces "optimal" solutions that are internally contradictory from the economic viewpoint. (MCW)

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 2375, 2662, 2663, 2664, 3315, 3317, 3318, 3324, 3339, 3341, 3360, 3387, 3803, 3822, 3823, 3829, 3830, 3831, 3832, 3833, 3835, 3879, 3880, 3881, 3894, 4342

3326 Background materials on U.S.—U.S.S.R. cooperative agreements in science and technology. Report prepared for the Subcommittee on Domestic and International Scientific Planning and Analysis of the Committee on Science and Technology, U.S. House of Repesentatives, Ninety-Fourth Congress, First Session. Washington, DC; Congressional Research Service (1975). 32p. GPO.

Abstracts were prepared for two agreements between the U.S. and the USSR dealing with energy and energy conservation and with peaceful uses of atomic energy; these are two of the eleven texts of the U.S.—USSR cooperative agreements given in Appendix I. Two additional appendixes furnish data on committee members, working groups, and projects. The background and signing of the initial agreement are given briefly, along with comments on the first three years and concluding remarks and observations. (MCW)

3327 Cooperation in the field of energy. Agreement between the United States of America and the Union of Soviet Socialist Republics signed at Moscow, June 28, 1974. pp 61-67 of In Background materials on U.S.—U.S.S.R. cooperative agreements in science and technology. Washington, DC; Congressional Research Service (1975).

Treaties and Other International Acts Series 7899.

The main objectives of such cooperation (Article II) are: (1) to use the scientific and technical potential of both countries to accelerate by cooperative efforts research and development in the areas of existing and alternative sources of energy as well as to increase effectiveness in the use of energy and its conservation, and (2) to achieve a better mutual understanding of each country's national energy programs and outlook. The eight additional articles further explain the agreement. Upon signature, the Agreement will remain in force for five years and automatically be extended for five-year periods unless either party wishes to terminate the agreement. (MCW)

3328 Proposed rulemaking and pubic hearings regarding energy efficiency improvement targets. *Fed. Regist.* (*Wash., D.C.*); **41**: No. 95, 19977-19981(14 May 1976). (10CFR430).

From Energy Administration, 10CFR430, Federal Energy Administration—Energy conservation program for appliances.

Proposed rules prescribing an energy efficiency improvement target for each of the following appliances are presented: refrigerators and refrigerator-freezers; freezers; dishwashers; clothes dryers; water heaters; room air conditioners; home heating equipment (not furnaces); television sets; kitchen ranges and ovens; and clothes washers. A partial list of potential design changes for each of the covered products is listed. (PCS)

3329 Proposed new Form No. 163. *Fed. Regist.* (*Wash., D.C.*); **41**: No. 168, 36402-36484(27 Aug 1976). (18CFR141).

From Conservation of Power and Water Resources, 18CFR141, Federal Power Commission—Corporate and financial report for Class C and Class D electric utilities and licensees.

To incorporate into a readily retrievable data processing system the corporate information and financial data currently submitted to FPC, it is proposed herein that the Annual Report Form No. 1F would be subdivided into two separate and distinct reporting portions. The corporate information and financial data portion would be embodied in a new report Form No. 163 under a new reporting system. The general changes which are being proposed to the Commission's reporting requirements for the new report Form No. 163 are as follows: (1) For the most part, the requirements for all beginning of year figures (or end of previous year figures) and all comparison figures (increases/decreases and previous year/month figures) have been eliminated. (2) Duplicative data elements (data elements appearing on more than one schedule) have been eliminated to the extent feasible. (3) The filing requirement for certain information that experiences little change from year to year (often referred to as fixed data) is proposed to be reported completely in the initial submission, with only changed values being reported in subsequent submissions.

3330 Proposed rulemaking. Report of generating plant, technical, environmental, and operating data: New Form No. 156. *Fed. Regist.* (*Wash., D.C.*); **41**: No. 171, 36926-36927(1 Sep 1976). (18CFR141).

From Federal Power Commission.

The data collected on various schedules will provide the Commission with information on plant construction cost and annual production expenses of nuclear, hydro, combined cycle, internal combustion, gas turbine, and pumped storage electric generating plants. The schedules will also provide data on plant design, plant and unit additions, jointly owned plants and units, plants and units under construction, and plant and unit retirements. There would be some instructional changes in the new schedules. Otherwise, no new data would be required.

FOSSIL FUELS

REFER ALSO TO CITATION(S) 3312

3331 Fossil Fuel and Advanced Systems Division. Progress report for the period ending July 1975. Palo Alto, CA; Electric Power Research Institute (1975). 47p. Carol Poole, Central File, EPRI, P.O. Box 10412, Palo Alto, CA.

Separate abstracts were prepared from the feature articles, Stacks vs Scrubbers by Kurt E. Yeager and Laser Fusion by L. King Isaacson. Staff reports are included on materials support; gasification, liquefaction, direct utilization, environmental control and combustion, resource extraction and preparation, and supporting research in the Fossil Fuels Department; and thermal-mechanical energy conversion and storage, electrochemical energy conversion and storage, solar energy, geothermal energy, and fusion in the Advanced Systems Department. Reports from the Division Committee, Fossil Fuel Task Force, and Advanced Systems Task Force are included under Advisory Group Matters. The Division organization chart is included, along with professional staff change and a list of reports issued since January 1975. (MCW)

COAL

REFER ALSO TO CITATION(S) 2335, 2336, 2337, 2341, 2347, 2348

3332 (RED—76-81) Status and obstacles to commercialization of coal liquefaction and gasification. (General Accounting Office, Washington, D.C. (USA)). 5 May 1976. 71p.

In his 1975 State of the Union message, the President called for accelerated development of the Nation's energy technology and resources and proposed a set of energy supply and conservation measures to reduce the United States dependence on foreign oil by 1985. As part of these measures, he proposed that the Government provide financial and other incentives to stimulate investment in a number of commercial-scale synthetic fuel plants. In addition, he set a goal to produce the equivalent in synthetic fuels of 1 million barrels of oil a day by 1985. In June, 1975, US ERDA projected $2^1/_2$ million barrels of oil a day and $^1/_2$ to $1^1/_2$ million barrels of oil equivalent from first-generation coal liquefaction and gasification plants, respectively, by 1985. These estimates are now being revised to 250,000 to 500,000 barrels of oil a day from coal gasification processes by 1985. ERDA is supporting several second-generation coal gasification processes for high-Btu gas, low-Btu gas and also several second-generation coal liquefaction processes. It is anticipated that some of these processes will be developed successfully and that plants could then be built that would reduce the cost of synthetic oil and gas by 15 percent or more. The status and financial funding of the individual projects are given. Finally, constraints to commercialization are discussed, including: recent Federal Power Commission rulings, capital requirements, cost escalation, product competitiveness, technical risk, coal availability, water availability, and equipment and materials. (LTN)

PETROLEUM

REFER ALSO TO CITATION(S) 2358, 2372, 2375

3333 Social and economic impact assessment of Alaska Outer Continental Shelf petroleum development. Fairbanks, AK; University of Alaska (1975). 97p. Alaska Outer Continental Shelf Office, Bureau of Land Management, U.S. Dept. of Interior, Washington, DC.

The document is a plan to study the effects of petroleum development of Alaska's Outer Continental Shelf on the physical, social, and economic environments. A three-day workshop was held on September 23-25, 1975 in Anchorage and a draft study plan was prepared by the Alaska Sea Grant Program and it was then given public review at a conference held in Anchorage on November 11-13, 1975. The reports and comments from these two meetings were used to develop this document. After describing the program goal and program rationale, the program design relates the interrelations among the physical, economic, social, individual human, and political phenomena that condition human welfare. The analysis is organized in terms of geographic entities—the state of Alaska as a whole, the several regions within which the oil and gas development will take place and, within these regions, the local communities or places of population congregation or social-cultural integration takes place. The development regions and local impact areas, research elements, and program management are presented. Additional data are included in ten addendixes (MCW)

3334 Petroleum refineries in the United States and Puerto Rico. Washington, DC; Department of the Interior (1976). 17p. Division of Fuels Data, Bureau of Mines, Dept. of the Interior, Washington, DC 20241.

On January 1, 1976, there were 287 refineries in the United States with a total crude oil distillation capacity of 15.4 million barrels per calendar day. In addition, these refineries reported 28,500 barrels per day capacity of downstream facilities to which crude oil is charged directly. Of the total crude oil distillation capacity at the beginning of this year, 560 thousand barrels per day were shutdown. Three refineries in Puerto Rico reported a total crude oil distillation capacity of 283,800 barrels per day, including 36,700 barrels per day operable shutdown. On January 1, 1976, in the U.S. there was under construction 1,057,878 barrels per day of additional crude oil distillation capacity and 97,600 bar-

rels per day for replacement of existing capacity. Expressed in terms of gasoline production, the total capacity of cracking, reforming, coking, and alkylation facilities in the United States at the beginning of 1976 was 7.2 million barrels per day, with 2.1 percent of the capacity being shut down on Jan. 1, 1976. Additional facilities under construction at the beginning of 1976 are expected to increase the output of cracking, reforming, coking, and alkylation facilities by 78,237 barrels per day. Shutdowns result from inefficient operational facilities. (MCW)

NATURAL GAS

3335 Underground storage of natural gas by interstate pipeline companies, calendar year 1974. Washington, DC; Federal Power Commission (1975). 33p. Federal Power Commission, Bureau of Natural Gas, Washington, DC.

At the end of 1974, there were 367 gas storage fields in operation in 26 states, up from 360 in 1973. Of these, 198 were reported by pipeline companies subject to the Commission's jurisdiction. Liquefied natural gas storage projects are not included with the underground storage fields in this report. The growth in active underground gas storage fields in the U. S. from 1916 to the end of 1974 is charted. Data compiled in the three sections that follow are: capacity, utilization, and certification of underground natural gas storage fields by jurisdictional pipeline companies in 1974; estimated cost of storing gas underground in 1974; and winter 1974-1975 storage. Data on underground gas storage, deliverability, and peak day use for jurisdictional companies as of December 31, 1973 are included for 32 companies in Appendix 1. Percent of gas from storage during highest consecutive 3-day system peak by area vs year (1963-1973) is charted in Appendix 2. (MCW)

HYDROGEN AND SYNTHETIC FUELS

REFER ALSO TO CITATION(S) 3359, 3360

3336 Technical prospects for commercial and residential distribution and utilization of hydrogen. Pangborn, J.; Scott, M.; Sharer, J. (Inst. of Gas Tech., Chicago). *Energy Commun.*; **2**: No. 5, 419-458(1976).

Hydrogen has been suggested as a fuel gas to eventually replace natural gas in commercial and residential heating and cooking applications. After transmission from a production site to a city gate, the delivery of hydrogen would be made through the pipelines of conventional (natural gas) distribution systems. It would be combusted in appliances with suitably modified burners. The flow rates and pressures of a gas distribution system using hydrogen probably will be different from those for natural gas. Increased operating pressures are predicted for hydrogen flow conditions of equivalent (to natural gas) energy delivery. Leakage is not considered an especially severe problem with hydrogen. Operating conditions for appliance burners will be different for hydrogen in terms of primary air and probably delivery pressures. Flashback and noisy operation must be prevented. Replacement of burners for hydrogen operation is possible.

ELECTRIC POWER

REFER ALSO TO CITATION(S) 2662, 2664, 3313, 3320, 3329, 3330, 3331, 3346, 3347, 3348, 3349, 3350, 3351, 3352, 3353, 3354, 3355, 3356, 3357, 3358

3337 Efficient electricity use: a practical handbook for an energy constrained world. Smith, C.B. (ed.). Elmsford, NY; Pergamon Press Inc. (1976). 986p. Pergamon Press Inc., Maxwell House, Fairview Park, Elmsford, NY 10523 $45.00.

Abstracts were prepared for the fourteen chapters of the handbook that focus on specific techniques to attain more efficient use of energy by industry, commerce, residential property, agriculture, transportation, and the communications sectors of the economy. Conversion factors, engineering data, the concept of available work, and a review of energy management regulations and governmental policies affecting efficient electricity use are additional data included in four appendixes. (MCW)

3338 Should utility rates be redesigned. Uhler, R.G. *EPRI J.*; **1**: No. 2, 12-17(Mar 1976).

An intensive EPRI-EEI program, Electric Utility Rate Design Study, is assessing conceptual and technological problems of peak-load pricing and load management for different regions of the United States. The program was begun at the request of the National Association of Regulatory Utility Commissioners (NARUC). The EPRI and the EEI organized a Plan of Study composed of 10 topics. In this article the author summarizes a few of the topics contained in the Plan. The 10 topics are: analysis of various pricing approaches; elasticity of demand for electricity; rate experiments for smaller customers; costing for peak load pricing; ratemaking; measuring advantages of peak load pricing; metering, technology for utilization; mechanical controls; and customer acceptance. The organizing of the program is reviewed briefly; it is proceeding in a series of five phases to: (1) assess the state-of-the-art and completeness of empirical knowledge; (2) appraise conceptual tools and mechanical equipment presently available; (3) assess what still needs to be developed; (4) evaluate the costs and benefits of such development; and (5) fashion compromises when costs appear to exceed benefits. An overview report was to be submitted to NARUC in September 1976. More than 100 people are assigned to the 10 task forces; 25 are on the 3 supervisory committees, and 10 to 12 consulting firms are undertaking one or more tasks. (MCW)

3339 Just and reasonable national rates for sales of natural gas from wells commenced prior to January 1, 1973. *Fed. Regist. (Wash., D.C.)*; **41**: No. 145, 31184-31197(27 Jul 1976). (18CFR2).

From Conservation of Power and Water Resources, 18CFR2, Federal Power Commission—General Policy and Interpretations.

General policy for setting natural gas prices is explained and defended in context of the Commission's procedural rules. Specific methodology defended includes cost of service (rate of return; normalization of exploration and development expenditures; federal income taxes; minimum rate); cost allocation; revenue impact; and rate design factors (market value royalties, waiver of refund credits, and pipeline production). All applications for rehearing, reconsideration and/or clarification of Opinion No. 749-A were denied with appended instructions for computing rate refunds due under section 4(e) and section 7(c). As defined by 18 CFR 157.40, small producers need not make rate filings but are entitled to collect 130 percent of the minimum rate. (PCS)

3340 Practical approach to peak-load pricing. Grainger, G.H. (Wisconsin Public Service Corp., Green Bay, WI). *Public Util. Fortn.*; **98**: No. 6, 19-23(9 Sep 1976).

The article deals first with areas of economic theory that do not reflect practicality and the realities of the electric utility industry; secondly, with a practical philosophy regarding peak-load or time-of-use pricing; and thirdly, with a methodology for peak-load costing and rate design. Four specific areas of economic theory covered are: optimum allocation of sources; adjustment of marginal costs to equal revenue requirements; loss-of-load probability; and what is the correct marginal cost. The author is critical of some efforts to apply pure economic theory on marginal costs to the redesign of electric utility rates, but he does recognize the necessity of addressing the issue of peak-load or time-of-day pricing. Such pricing can better reflect cost of service and result in a more efficient allocation of resources, he says. He concludes that optimum allocation of resources is not justification for marginal cost pricing of electricity. After discussing 6 criteria of the elements of practical peak-load pricing, a methodology for costing and rate design is presented. (MCW)

ELECTRIC POWER GENERATION

REFER ALSO TO CITATION(S) 3361

3341 (CRWR—113) Establishment of operational guidelines for Texas coastal zone management. Final report on example application I. Implications of alternative public policy decisions concerning growth and environment on coastal electric utilities. Moseley, J.C. II. (Texas Univ., Austin (USA). Center for Research in Water Resources). 1973. 228p. Univ. of Texas, Austin.

For Office of the Governor of Texas, Division of Planning Coordination.

The principal objective of this project was to develop a methodology for assessing the implications of alternative public policies concerning growth and environmental control in electric power production, including a feasibility demonstration on a real-world problem. Public policies, rather than specific regulatory aspects were stressed because there is a crying need to carefully examine alternative policies for possible adverse impacts. This would be greatly preferable to heated confrontations over specific regulatory decisions, although the author realizes that the latter approach presently prevails. This effort simultaneously examined three alternative growth policies and three alternative cooling policies in the Corpus Christi area; this results in nine alternative futures. The growth policies ranged from zero population growth to

an extrapolation of past trends. Various cooling techniques were applied to meet environmental criteria, which ranged from "continuation of present practice" to "zero-discharge," while satisfying electrical demand for the three growth levels. The implications of these "alternative futures" upon natural resource requirements, costs, and possible socio-economic impacts were carefully displayed and assessed.

3342 Technologien zur besseren energienutzung in waermekraftwerken. (Technologies for improved energy utilization in thermal power plants. Proceedings of a conference held 4—5 February 1976, in Juelich, Germany). Juelich, Ger.; Kernforschungsanlage (1976). 92p.

The purpose of the conference was to point out: the status of power plant engineering and possible development approaches; today's industrial research activities in the field of power plant engineering; limits to improved energy utilization from a technical, industrial, and economic point of view; and research objectives aimed at improved utilization of fossil energy sources. The aim of new developments of electricity generation from coal is for an improvement in efficiency and in environmental protection. Improvement in efficiency rates from coal-derived steam is small and so efficiency rate improvements must stem from novel techniques. The following methods are discussed: direct conversion of chemical energy into electricity using fuel cells; increase of process temperature by using gas turbines and combined gas/steam turbine processes; application of conversion processes producing not only electricity, but also other kinds of energy in a third stage, e.g., steam; and processes using nuclear energy in addition to coal and producing electricity as well as energy in a third stage. All these processes require gaseous energy from coal, either as chemical energy or in the form of heat. One paper was devoted to the production of stored heat by means of extraction steam in load volleys and its utilization during peak demand. The final presentation dealt with the requirements of the Technical Instruction on Air Pollution Control (TA-Luft 1974) and their impact on energy production. The editor concludes that there are many unused possibilities for improved utilization of energy in thermal power plants. (MCW)

ELECTRIC POWER TRANSMISSION AND DISTRIBUTION

3343 Packing the power corridor. Young, F.S. *EPRI J.*; 1: No. 4, 7-11(May 1976).

Energy research efforts are focused on extending usefulness. Exploration to establish new reserves is one direction. Technology development for more-efficient resource conversion is another. In this context, the unique attributes of electricity ensure that its use will increase more rapidly than that of any other energy form. But more electricity is not just a matter of better fuel-cycle efficiency or more generation capacity. It also means more transmission capability. The high-voltage transmission line is a vital performer as new capacity is built at one end, new loads added at the other, and new environmental values are imposed along the ROW. This EPRI state-of-the-art feature on power transmission covers the subjects of transmission functions, power transfer efficiency, environmental issues, high phase-order transmission, and more load and longer lines for economic reasons. (MCW)

CONSUMPTION AND UTILIZATION

REFER ALSO TO CITATION(S) 3328

3344 (HMI-B—172) An approach to the determination of physical-chemical limits of energy consumption for the transition to a stationary state. Zimen, K.E. (Hahn-Meitner-Institut fuer Kernforschung Berlin G.m.b.H. (Germany, F.R.). Bereich Kernchemie und Reaktor). Feb 1975. 13p. (In German). INIS.

3 figs.; 24 refs.

A model is given of energy consumption, and a program for its application is described. Previous models are mainly criticized on the grounds that new technological developments, as well as adjustments due to learning processes of homo sapiens, are generally not sufficiently accounted for in these models. This new model is therefore an attempt at the determination of the physical-chemical limiting values for the capacity of the global HST (homo sapiens - Tellus) system or of individual regions with respect to certain critical factors. These limiting values determined by the physical-chemical system of the earth are independent of human ingenuity and flexibility.

3345 (NSF-RA-N—74-242) Tax and other legal incentives to the increased production of energy resources. Final report. Johnson, M.T. (Houston Univ., Tex. (USA)). 20 Jan 1975. 23p. Dep. NTIS $3.50.

Taxes and related legal incentives that might be instituted or supported by the State government to increase the State's energy supply are discussed. Federal policies and regulations are intertwined with and limit state authority in most areas and these are discussed. Federal tax laws affecting energy supply are discussed for petroleum, natural gas, coal, and uranium. State action to increase the energy supply for petroleum, natural gas, and electric power is presented. The U.S. Energy Research and Development Administration was created to coordinate and effectuate the development of all energy sources, including the policy planning, coordination, and support and management of research and development programs. It is suggested that the State of Texas might also create an agency to coordinate state energy planning and research. 47 references (MCW)

3346 Energy-constrained society. Smith, C.B. pp 1-24 of In Efficient electricity use: a practical handbook for an energy constrained world. Smith, C.B. (ed.). Elmsford, NY; Pergamon Press Inc. (1976).

World-energy use is presently estimated to be 3×10^{11} GJ/yr. The United States alone uses approximately 1×10^{11} GJ/yr. An increasing fraction is being used in the form of electricity. In the United States today, it is more than 20 percent and is expected to approach 50 percent by the end of the century. Current energy use in the United States is 300 GJ/person-year. If the entire world population had this requirement, the world's fossil fuel reserves would disappear in 30 years. Thus, it is inevitable that the world of tomorrow will consist of many energy-constrained societies. The constraints include: (1) a biological limit, determined by the level of energy use which ceases to be biologically tolerable; (2) an economic limit, which depends on national wealth, energy prices, technological know-how, and national resources; (3) a self-sufficiency limit, which depends on the availability of domestic versus imported energy forms; (4) a socio-cultural limit, which depends on the social tolerance of energy use and the social costs which must be paid in exchange for a given level of energy use; and (5) a subsistence limit, which is based on the minimum energy input necessary to feed the population and to provide for minimum amenities of life. Improving efficiency is of fundamental significance in terms of resource utilization, cost, and the environment. In the United States a 15 percent increase in electricity use efficiency by the year 2000 could reduce the projected number of 1000-MWe generating plants by between 300 and 400. The savings in capital cost alone would be $150 to $200 billion; savings in fuels (approximately 3×10^{10} GJ/yr or $6 to $12 billion/yr) would be significant as well. (From Summary)

3347 Industrial energy use. Fazzolare, R. (Univ. of Arizona, Tucson). pp 25-134 of In Efficient electricity use: a practical handbook for an energy constrained world. Smith, C.B. (ed.). Elmsford, NY; Pergamon Press Inc. (1976).

Industry as a whole utilizes about 40 percent of U.S. energy resources, of which roughly 40 percent is natural gas, 25 percent petroleum, 25 percent coal, and 10 percent is from hydro and nuclear sources. Approximately 65 percent of the industrial sector's resources are used for process heat application (40 percent for process steam and 25 percent for direct heat); an additional 25 percent is used to produce electric energy which is used primarily for motive operations. The remaining 10 percent is used as feedstock materials. The chapter shows that overall energy savings in the range of 30 to 50 percent are possible in industrial operations over the time period 1975-2000. Immediate reductions (10 to 15 percent) in energy use can be anticipated through improved housekeeping and minor modifications in operation with a small financial outlay. An additional 10-15 percent savings in the next 2-5 years will require capital expenditures for process redesign and new equipment. Over the long-term (5-25 years) additional savings in the range of 10-20 percent are possible, but only with significant equipment and process changes involving heavy investments. Improved efficiency of energy depends on the application of sound management principles, organization, and planning. Energy accounting and program progress reviews should be established. The initial technical implementation is based on improved maintenance procedures and the elimination of waste points in the operation. Systems and process redesign can lead to further opportunities in fuel and electricity savings for the longer term. Improvements in combustion processes, efficient motive operations, heat recovery and recycle, combined power cycles and steam generation, power recovery, and energy effective product design are some of the technical means to achieve efficient energy use in industry. (From Summary)

3348 Commercial energy use. Taussig, R.T. (Columbia Univ., New York); Smith, C.B. pp 135-214 of In Efficient electricity use: a practical handbook for an energy constrained world. Smith, C.B. (ed.). Elmsford, NY; Pergamon Press Inc. (1976).

Total energy use in commercial establishments was 14.5 percent of the nation's energy budget in 1968. Roughly one third of that was electrical energy, or 24 percent of the nation's electricity use. The major use of electricity in the commercial sector is for air conditioning, refrigeration, lighting, electric motors for elevators, escalators, and office machinery. The fastest growing electricity use was for air conditioning and lighting over the period 1960-1968. While fluorescent lighting supplies more illumination in the commercial sector than in the residential sector, so that the potential for improvement is not so great, more-efficient lighting systems and use of lighting can be designed. Other options for improving the efficiency of commercial electricity use involve integrated energy systems, heat pumps, shading, insulating and reflecting glass, waste heat recovery, and other architectural considerations. Because of projected building trends, it appears that near-term energy savings will occur principally in old, not new buildings, through changes in operation and by corrective modifications, repair, and maintenance of existing equipment. The options for energy savings are illustrated by a series of case studies as well as by the chapter text. The results indicate an overall potential for saving 15 to 30 percent of commercial energy use, which corresponds to approximately 2 to 5 percent of U. S. energy use. The needed improvements in efficiency are assumed to take place over the period 1975-2000. Savings in electricity could reduce the projected number of power plants. However, the savings in power plants could be offset by a trend toward increased use of electricity for commercial heating. 67 references. (From Summary)

3349 **Residential energy use.** Woodson, T.T. (Harvey Mudd Coll., Claremont, CA). pp 215-299 of In Efficient electricity use: a practical handbook for an energy constrained world. Smith, C.B. (ed.). Elmsford, NY; Pergamon Press Inc. (1976).

The residential sector energy input was 12.2 x 10^9 GJ/yr (11.6 x 10^{15} Btu/yr) for 1968. This was 19 percent of U. S. total energy use for the same year. The average per capita direct residential energy use was 61 GJ/person-year. Energy wastage is estimated as at least 30 percent of the sector total, the most important causes being the following: (1) insufficient thermal insulation; (2) undesired air infiltration; (3) excessive lamping; (4) appliance operation; (5) insufficient knowledge of power consumption facts; and (6) up-to-now low cost of energy. Suggested economics are herein proposed under the categories of: (1) improved operating strategies and methods; (2) recommended home modifications by the owner/lessor; and, (3) opportunities for redesign by the manufacturer. The major actions suggested within the above headings are: (i) control settings, schedules of use, ventilation and shading, maintenance, cost comparisons, delamping, careful purchasing, clothing adaptation, color choice, cold water laundry; (ii) added insulation, weather stripping, duct and piping changes, fluorescent lamps, sector light switching, attic ventilation, other thermal insulation, awnings, pilot light changes, evaluation of central versus room air conditioning, solar pool and water heating, tree planting, roof changes, other site considerations; and, (iii) substitution of less energy-intensive materials, designs promoting material salvage, mechanism efficiency data, tabulation of principles available, scanning lists of suggestions, process alternatives, and revision of present methods of scrap salvage. Total projected savings are in the range of 25 to 45 percent of residential energy use. (From Summary)

3350 **Transportation and communication use.** Spencer, R.B. pp 301-362 of In Efficient electricity use: a practical handbook for an energy constrained world. Smith, C.B. (ed.). Elmsford, NY; Pergamon Press Inc. (1976).

Between one fourth and one third of the United States' total energy budget is used for transportation. However, only a small fraction of the energy used for transportation is used in the form of electrical energy. Conversely, communication energy requirements are exclusively in the form of electricity. Electrical vehicles and trains represent a viable means of reducing atmospheric pollution and conserving valuable fossil fuels. With recent developments of battery systems having more attractive power and energy densities, the prospect is improving for the all-electric car. While the energy-conversion efficiency may not be superior to other engines, the important advantages include: flexibility of primary fuel sources in electricity generation (e.g., nuclear), possibility of linkup with centralized power distribution systems under or alongside roads, greater ease of designing and implementing automatic control of individual vehicles on highways and freeways, and higher system efficiency since in a central power station the waste heat could be beneficially utilized. Electric trains could have an impact on society if their use increases for inter- and intra-city mass rapid transit. Underground systems will be forced to utilize electrical power from the standpoint of health, pollution, and economic factors. Electricity and information flow via computers, numerical control, telephone, radio/television, telegraph, and microwave communications utilize a considerable quantity of electrical energy. With the advent and implementation of miniaturized solid-state electronics in electronic communication devices, the electric utilization efficiency will increase and the electrical power requirements will decrease per unit in service. 35 references. (From Summary)

3351 **Agricultural energy use.** Taylor, G.B. pp 363-432 of In Efficient electricity use: a practical handbook for an energy constrained world. Smith, C.B. (ed.). Elmsford, NY; Pergamon Press Inc. (1976).

Accompanying the trend in the U. S. toward "industrial agriculture" are new solutions to age-old problems of crop production, insect pests, and soil yields. The use of specialized machinery such as automatic pickers and sorters, in-field vegetable packing, sprinkling systems, refrigeration, chemical fertilizers and pesticides has greatly increased agricultural production efficiency. However, all the new innovations in agricultural equipment, food processing, and storage require increasing amounts of energy. As has happened in many other industries, the past abundance and low cost of energy has led to energy-intensive practices in the agricultural industry. Such examples as fattening beef cattle in feed lots, packaging and displaying food for consumer appeal rather than efficiency, potentially destroying productive land through overproduction without proper long-range planning, must be carefully reviewed and corrected to insure a continuing supply of agricultural products. In summary, the demand for electrical energy is increasing as the agricultural industry grows. Solutions to the problems facing this industry will place new demands on electricity production. A significant potential exists for more-efficient agricultural electricity use; realization of this potential will require new attitudes and approaches in both small farms and agribusinesses. 45 references. (From Summary)

3352 **Heat sources.** Howard, G.E. pp 433-482 of In Efficient electricity use: a practical handbook for an energy constrained world. Smith, C.B. (ed.). Elmsford, NY; Pergamon Press Inc. (1976).

The purpose of this chapter is to recommend more-efficient methods for use of heat sources and heat-source systems which are already documented in literature or appear to be feasible based on analyses. For the industrial sector, generally applicable methods include: diligent management of heat sources (operating and maintenance practices); the use of on-line computer controls for operation of large thermal processing plants; improved furnace designs and operating schedules; use of recovered heat to generate electricity in conjunction with process steam systems; improved utilization of waste process heat for lower-level process use and building heating; and heat conservation by recycling of waste materials. For the commercial sector, generally suitable methods include: maximum use of building design techniques to minimize heating and air conditioning loads; greater emphasis on heating and air conditioning systems designs which minimize power and thermal requirements; lower-loss water-heating systems; lower-loss refrigeration systems; and improved equipment designs. For the residential sector, many methods similar to those applicable to commercial systems are appropriate, including: improved building designs; minimum power consumption systems; lower-loss water-heating systems and refrigeration systems; and improved equipment designs.

3353 **Light energy sources.** Smith, C.B. pp 483-533 of In Efficient electricity use: a practical handbook for an energy constrained world. Smith, C.B. (ed.). Elmsford, NY; Pergamon Press Inc. (1976).

The major use of lighting is in buildings. Improved efficiency can result from the following technological changes, all of which can be implemented in the near-term: increased use of natural light; non-uniform illumination practices; revised illumination standards; and use of more-efficient lamps and devices. With currently available technology, it is estimated that energy use in lighting could be reduced: (1) 10 percent by better controls, e.g., turning lights off when not in use; (2) 30 percent by widespread substitution of fluorescent lamps for incandescent; (3) 20 percent by use of more-efficient lamps in industrial applications, for an ultimate total of up to 60 percent. Several case studies are presented to: (1) support the conclusions reached in this chapter; (2) show typical applications in industry and commerce of the concepts presented in the chapter; and (3) show economic savings that can result. In a typical example, the use of high-pressure sodium lamps in an industrial building reduced electricity use by 50 percent and the added investment was repaid in less than three years. Improvements in maintenance cost and lamp life also resulted. New technological developments, such as light-emitting diodes, have potential for providing small-capacity light sources in the near future, although they will have to be improved at least two orders of magnitude in output and performance before they will be useful

for general lighting. Improving lighting efficiency has the further advantage of saving money as well as other energy costs such as air conditioning.

3354 Motion (mechanical energy sources). Spencer, R.B. pp 535-593 of In Efficient electricity use: a practical handbook for an energy constrained world. Smith, C.B. (ed.). Elmsford, NY; Pergamon Press Inc. (1976).

Improvements in the utilization efficiency of the electrical prime movers can be achieved by good maintenance practices. The efficiency of electric motors can be significantly increased (particularly for small motors rated less than 1 kW) by means of returning to original motor design and manufacturing practices. In recent years the older practices have been discarded to achieve less-expensive motors, but the result has been lower efficiencies. With current energy price trends, higher-initial-cost motors will be cheaper in the long-term when energy use, maintenance requirements, and usable life are considered. Recent technological developments can also provide greater electrical use efficiency (e.g., utilization of pulse-width modulation techniques for the control of motor speed). Material shaping and forming operations have potential for improved electrical use efficiency. Some examples are the use of cold forgings from easily wrought alloys to replace hot forgings; use of fine blanking (a shaping operation that uses close-fitting dies) to produce precision stampings requiring no subsequent finishing, thereby lowering the energy content of the part; and the use of stretch forming (pre-stretching the material 2 to 3 percent prior to forming) that reduces the energy used to form the part and increases the strength of the finished part. The transport of material and products within a given industrial facility presents special requirements for electrical energy use. Based on estimates of potential improvements in motor efficiency and projected electricity demand, it is concluded that there is a potential for saving electricity equivalent to that generated by 50 to 100 1000-MWe power plants over the period 1975-2000. 20 references.

3355 Electrolytic and electronic processes. Taylor, G.B.; Bird, E.F.; Perez, R. pp 595-619 of In Efficient electricity use: a practical handbook for an energy constrained world. Smith, C.B. (ed.). Elmsford, NY; Pergamon Press Inc. (1976).

The use of electrochemical processes such as electrosynthesis, electrowinning, electrochemical recycling, and electrochemical matching should be considered as alternatives to conventional processes where improved efficiency is possible. Further development of fuel cells and electrochemical storage technology is needed in order to produce the high efficiencies necessary for their successful application to energy production on a large scale. Direct energy conversion with fuel cells could play an important role in future electricity production. With improvements in ion conduction, electrocatalysis, and oxygen reduction, for example, each residence or business could produce electricity on demand, using fuels ranging from coal gas to hydrogen with greater efficiency. Production of more-efficient batteries for electrochemical storage of electrical energy will serve to provide two greatly needed capabilities: use of electrical power for transportation and off-peak storage of electricity produced by solar and nuclear generation plants. Basic research and development of electrode mechanisms, materials, configuration, and charging control is needed. The use of hydrogen produced by high temperature electrolysis of steam to be used in both fuel cells and energy storage must be investigated. Corrosion damage to parts, equipment, vehicles, and structures accounts for approximately 1 percent of the United States GNP. It is corrosion that creates loss in fuel cells and batteries and limits the life of these systems. Basic research in corrosion prevention will play an important part in preserving natural resources and energy reserves.

3356 Energy use in urban and suburban dwellings. Kelber, W.F. pp 621-649 of In Efficient electricity use: a practical handbook for an energy constrained world. Smith, C.B. (ed.). Elmsford, NY; Pergamon Press Inc. (1976).

Architects and engineers who specialize in the design of residential dwelling units and manufacturers who provide labor-saving, comfort, or recreational devices must no longer assume that energy costs are of secondary concern. Nor can it be assumed that, because a certain fuel or energy source is presently available and economically competitive, it will prove to be the proper selection over the lifetime of the structure. Design concepts, therefore, must be evaluated on the basis of energy costs and projected availability of energy sources. Cost analyses must be made on an overall system basis and must include installation, operation, and maintenance costs of energy-using devices as well as related building costs. The analyses also must include consideration of the life-time availability of energy sources. The functional arrangement of a residential dwelling unit has a major influence on energy use. It will be necessary for the designer to develop more energy-conscious functional arrangements and to analyze these arrangements on a life-cycle cost basis. One of the first considerations in the design of residential dwelling units will be methods of reducing energy loads, primarily heating and cooling loads, to a minimum. Heating systems that minimize transmission and standby losses are to be favored, particularly if it can be shown that the overall system efficiency exceeds that of alternate schemes. Architects and engineers, in close coordination with industry, must set standards of performance for both the efficient use of energy and cost-effectiveness of the overall design. This will involve optimum utilization of available building materials and equipment to minimize energy loads while maximizing energy use efficiency. 21 references.

3357 Energy use in non-residential buildings. Slattery, E.F. pp 651-708 of In Efficient electricity use: a practical handbook for an energy constrained world. Smith, C.B. (ed.). Elmsford, NY; Pergamon Press Inc. (1976).

Architect-engineers, specializing in the design of all types of commercial establishments, public assembly, and monumental buildings are responsible for leadership in achieving national goals of more efficient energy use. Their success will depend to some extent on the cooperation of the regulatory agencies, the social and scientific community, and industry's ingenuity. Architect-engineers will need to reassess the impact of codes, building regulations, and recommended practices of the professional societies which impact energy demand and use. Significant changes from the energy use patterns of the period 1950-1970 will be required in the period 1980-2000. Building systems analyses will be particularly useful in determining where energy demand can be minimized and energy use efficiency maximized. Life-cycle cost comparisons of candidate systems design are expected to be an essential part of the architect-engineer's work in the 1980s. Planning for non-residential buildings to be constructed in the near future must include provision for the installation of supplemental energy sources and energy storage subsystems. This will require architect-engineers to maintain a current working knowledge of both conventional and alternative energy systems such as solar and wind energy plants. Architect-engineers should begin to develop concepts for increasing the energy use efficiency in existing non-residential buildings with remaining useful economic life. Use efficiency can be increased in the late 1970s by waste heat recovery apparatus, reduction of energy losses, and computer-managed energy usage. 21 references.

3358 Energy use in cities. Schoen, R. (Univ. of California, Los Angeles). pp 709-805 of In Efficient electricity use: a practical handbook for an energy constrained world. Smith, C.B. (ed.). Elmsford, NY; Pergamon Press Inc. (1976).

Energy use in cities is considered in an integrated or systemic manner. Emphasis is placed on actions that could improve energy use efficiency in the near-term (2-5 years). In reviewing the historical evolution of city design from prehistoric to modern times, it becomes apparent that general principles leading to efficient energy use have evolved. In ancient times these principles influenced the utilization of natural energy sources provided by wind, sun, and site. In modern times, the same principles or variations of them lead to effective use of man-made energy sources such as electricity. In the design of current or future cities, there are near-term technological options for improving energy use efficiency. Major options include those related to utility systems (combined power cycles, energy corridors, district heating, total energy systems); solid-waste recovery (reduction of volume to be disposed, heat recovery during incineration, conversion to fuels, energy-intensive by-product recovery-metals, glass); energy-efficient urban transportation (vehicle type selection, power sources, mode of operation); and, undergrounding of selected major buildings within cities (reduction of heat losses, reduced infiltration, energy and cost savings, improved land utilization). These and other concepts are discussed in the text and in a series of case studies illustrating the principles and concepts developed in the chapter. 63 references.

UNCONVENTIONAL SOURCES AND POWER GENERATION

REFER ALSO TO CITATION(S) 3331

OTHER

3359 Nebraska GASOHOL program providing food and fuel for the future: a summary. Scheller, W.A.; Mohr, B.J. Lincoln, NE; University of Nebraska (1976). 6p.

In an effort to provide a new domestic source of energy and stimulate the agricultural economy of Nebraska the 82nd Nebraska

Legislature (1971-72) passed bills which established a program to aid in the development of a grain alcohol industry in Nebraska through the introduction of an automotive fuel containing a blend of 10 percent agriculturally derived ethyl alcohol and 90 percent unleaded gasoline. This fuel is named GASOHOL. In order to encourage the sale and use of GASOHOL, the legislation provides a 3 cents per gallon reduction in the State gasoline tax on any such fuel sold. With this tax reduction the price of GASOHOL is competitive with that of unleaded gasoline. The Agricultural Products Industrial Utilization Committee (APIUC) was established to administer the GASOHOL program. Membership of the APIUC consists of four people actively engaged in farming, two in business, and one representative of the petroleum industry. In addition to describing the program, this report also has sections devoted to (1) the economics of grain alcohol production by fermentation, and (2) food and fuel for the future through GASOHOL.

3360 **Nebraska statutes: the basis for the GASOHOL program.** Lincoln, NE; University of Nebraska (1976). 3p.

Excerpts are compiled from revised statutes of Nebraska (-1943; Reissue of 1971; Cumulative Supplement 1974). One or more of the excerpts are included under one of the following categories: Declaration of Need for GASOHOL; Funding the Program; Use of the Fund; Administration of the Fund; and Tax Incentive for GASOHOL. (LMT)

3361 **Fuel cells: versatile power generators.** Fickett, A. *EPRI J.*; 1: No. 3, 14-19(Apr 1976).

The basic principles of operation of fuel cells are discussed, and the programs for research and assessment of large-scale fuel cell power plants are reviewed. It is stated that with a national fuel cell program in the offing, prospects are favorable for multifueled, modular, dispersible power plants to be in commercial use by 1985. An economic comparison of fuel supply options projected for 1985 is given. (WHK)

ENERGY CONVERSION

MHD GENERATORS

MATERIALS, COMPONENTS, AND AUXILIARIES

3362 (ANL-HEP-CP—76-29) **US SCMS dipole magnet system for the bypass loop of the U-25 MHD facility.** Niemann, R.C.; Wang, S.T.; Pelczarski, W.J. (Argonne National Lab., Ill. (USA)). 1976. Contract W-31-109-eng-38. 33p. (CONF-761015—1). Dep. NTIS $4.00.

From 3. US/USSR colloquium on magnetohydrodynamics power generation; Moscow, Union of Soviet Socialist Republics (USSR) (Oct 1976).

The Argonne National Laboratory is responsible for designing and constructing a superconducting dipole magnet system for use in the bypass loop of the U-25 MHD facility in Moscow. The system consists of the magnet and its cryostat, a helium refrigerator/liquefier facility, associated cryogenic and storage apparatus, power supply, the necessary vacuum and gas handling systems and an integrated control system. Presented in detail are the system design parameters. Reviewed are the magnet geometry, stability criteria, cryostat thermal and mechanical design, cryogenic system parameters, and controls. Summarized are the effects on stability of conductor surface covering, cooling passage height and orientation. The method of fabricating conductor splice joints by the use of ultrasonic welding techniques is described. Details of the diagnostic instrumentation system which permits dynamic monitoring of the magnet's thermal parameters, structural forces and component accelerations during system cool down and with the MHD channel in operation are included.

3363 **Aspects of closed-cycle MHD power generation.** Shair, F.H.; Hoffman, B.; Sherman, A. (General Electric Co., Philadelphia, Pa. (USA). Space Div.). pp 119-132 of In Materials associated with direct energy conversion. Rottenburg, P.A. (ed.). London; Institution of Chemical Engineers (1965).

From A.I.Ch.E. - I.Chem.E. joint meeting, symposium no. 5 on materials associated with direct energy conversion; London, UK (15 Jun 1965).

In order to obtain useful MHD generators for use in closed cycle nuclear power plants, studies are being directed toward the electrical conductivity of cycle working fluid. Since the maximum temperatures anticipated from nuclear reactors are far less than would be necessary for thermal ionization, some form of non-equilibrium ionization is necessary. In the present paper, an electron beam apparatus being used in conjunction with an argon-caesium MHD generator experiment for purposes of pre-ionization is described in detail. In addition, the operating characteristics of a long time closed-loop for boiling and condensing potassium for vapour MHD experiments are described. Finally, some results of theoretical studies considering the MHD interaction when the fluid is in a state of non-equilibrium are presented.

THERMOELECTRIC GENERATORS

DESIGN AND DEVELOPMENT

REFER ALSO TO CITATION(S) 2563, 2565

PERFORMANCE AND TESTING

3364 **High efficiency thermoelectric generator.** Marinescu, M. (Rumanian Academy of Sciences, Bucharest). pp 637-642 of In Power sources 5. Collins, D.H. (ed.). New York; Academic Press Inc. (1975).

From 9. international power sources symposium; Brighton, UK (17 Sep 1974).

See CONF-740908—.

A thermoelectric generator consisting of a semiconductor lying between two different metals is described. Operating conditions as well as thermoelectric performances are given and compared with the performance of thermoelectric generators of equal power output operating on the basis of the Seebeck effect. A qualitative analysis to explain the operation of the generator is also given.

THERMIONIC CONVERTERS

DESIGN AND DEVELOPMENT

3365 (TE—4202/4203-54-76) **Advanced Thermionic Technology Program progress report No. 5.** (Thermo Electron Corp., Waltham, Mass. (USA)). Nov 1975. Contract E(11-1)-3056. 16p. Dep. NTIS $3.50.

Theoretical calculations were made of the electron reflectivity for quantum mechanical models of the surface dipole layer. Research on plasma theory is summarized including the modification of the plasma program to include electron temperature gradient iteration and a series of tests using a pulsed triode converter with an electropolished arc cast tungsten emitter, a deposited tungsten oxide collector and a four wire molybdenum grid. Converter development is summarized including electrode screening for low temperature converters and evaluation of the tungsten oxide converter, titanium oxide converter, and lanthanum hexaboride converter. Also, component hardware development is summarized. (WHK)

FUEL CELLS

REFER ALSO TO CITATION(S) 3355

DESIGN AND DEVELOPMENT

REFER ALSO TO CITATION(S) 3361

3366 **Fuel cell set and method.** Strasser, K.; Hasenauer, D. (to Siemens Aktiengesellschaft). US Patent 3,935,028. 23 Sep 1974. Priority date 11 Jun 1971, German, Federal Republic of (F.R. Germany). vp.

A fuel cell set is described for the generation of electric energy through the reaction of gaseous reactants and a liquid electrolyte which is circulated, the fuel cell set comprising: a housing of compact construction; a plurality of fuel cells which are combined into at least one fuel cell battery disposed within said housing; an electrolyte regenerator, disposed adjacent said fuel cells within said housing, which removes reaction water from the electrolytic liquid; a pressure lock, disposed adjacent said regenerator within said housing through which the reaction water flows, said pressure lock comprising a gas chamber, a liquid chamber, and a liquid permeable asbestos diaphragm which separates the liquid chamber from said gas chamber, and said pressure lock gas chamber being coupled to said electrolyte regenerator condensation chambers; a heat exchanger, disposed adjacent said pressure lock within said housing, having a coolant which removes heat from the electrolyte and cooling chambers, said heat exchanger electrolyte chambers being coupled to said electrolyte regenerator electrolyte chambers; a supply tank for the electrolytic liquid

disposed adjacent said heat exchanger and coupled by a plurality of electrolyte flow lines to the electrolyte chambers of said electrolyte regenerator and said fuel cells within said housing; and a control unit, disposed adjacent said tank within said housing, which controls the flow of gaseous reactants, electrolytic liquid and reaction water and through which the gaseous reactants and coolant are supplied to and discharged from said fuel cell set.

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 3291, 3294

3367 Method of making a fuel cell. Conger, M.T.; Evans, T.A.; Villemain, H.F. (to Goodyear Tire and Rubber Co.). US Patent 3,935,050. 13 Sep 1973. vp.

A method of building an elastomeric fabric container is described comprising building a fluorocarbon elastomeric inner liner on a building form, applying a solvent solution of a fluorocarbon elastomer coating over the inner liner and laying up fabric over the coating while the coating is sufficiently fluid to strike through the fabric, to give at least one layer of fabric, covering the fabric with at least one coat of a fluorocarbon elastomer and curing the elastomer to give a finished container after removal of the building form.

3368 Method of fabricating a carbon—polytetrafluoroethylene electrode support. Baker, B.; Klein, M. (to Energy Research Corp.). US Patent 3,935,029. 19 Feb 1974. Filed date 18 Nov 1971. vp.

A method for the manufacture of an electrically conductive substrate for use as an electrode support in a fuel cell is described comprising the steps of: (a) blending a quantity of carbon with dry powdered polytetrafluoroethylene in a lubricant to form a homogeneous mixture, said polytetrafluoroethylene constituting from 6 percent to no more than 32 percent of the combined weight of said carbon and said polytetrafluoroethylene; (b) filtering lubricant from said blend to form a filtered mixture; (c) subjecting said filtered mixture to rolling forces effecting thickness reduction thereof, thereby forming a sheet of fibrillated polytetrafluoroethylene containing carbon and lubricant; and (d) removing the remainder of said lubricant from said sheet.

3369 Method for catalyzing a fuel cell electrode and an electrode so produced. Katz, M.; Kaufman, A. (to Union Technologies Corp.). US Patent 3,932,197. 18 Dec 1974. vp.

A process for catalyzing an inert, porous conducting particle, hydrophobic bonded, substrate supported electrochemical cell electrode is described which comprises contacting the inert, porous conducting particle, hydrophobic-bonded portion of said electrode with the electrolyte composition applying a non-alternating electrical potential across the electrode between the substrate and the electrolyte, the electrical potential being of sufficient magnitude to increase the rate at which the electrolyte enters and fills the porous conducting particles, then causing a soluble catalyst-containing compound to enter into solution in the electrolyte within the electrode structure and depositing insoluble catalyst from said electrolyte solution onto the conducting particles.

3370 Fuel cell cooling system using a non-dielectric coolant. Grevstad, P.E.; Gelting, R.L. (to United Technologies Corp.). US Patent 3,969,145. 13 Jul 1976. Filed date 21 Jul 1975. 10p.

A cooler for removing waste heat from a stack of fuel cells uses a non-dielectric coolant which is carried in a plurality of tubes passing through one or more separator plates in the stack. Preferably the coolant is water so that heat removal is by evaporation of the water within the tubes by boiling. The tubes are electrically insulated from the cells by a coating of dielectric material such as polytetrafluoroethylene. In one embodiment of the invention the cooler tubes are connected to the stack coolant supply conduits by dielectric hoses having a high length to diameter ratio to provide a several hundred thousand ohm impedance path in case of a flaw in the protective dielectric coating, in order that a short circuit of the stack does not occur.

ELECTROCHEMISTRY, MASS TRANSFER, AND THERMODYNAMICS

3371 (AED-CONF—75-404-021) The use of radiochemical techniques in fuel cell research. Meier, H. (Staatliches Forschungsinstitut fuer Geochemie, Bamberg (Germany, F.R.)). 1975. 7p. (In German). (CONF-7509112—12). INIS.

From General meeting of the German Chemical Society; Koeln, German, Federal Republic of (F.R. Germany) (8 Sep 1975).

17 figs. With abstract.

The utilization of metal chelates as catalysts in fuel cell research gives rise to special problems which cannot be solved by the usual methods, but may be well clarified by isotope technical methods. The electrocatalytic efficiency of polymer iron phthalocyanine (on carbon carriers) can be proved by the plotting of potential-current density curves. Two questions, however, remain unanswered: a) What is the solubility behaviour of the catalyst, and b) is there an additional stabilizing interaction between the metal chelate catalyst and the carbon electrode. To answer the first question, the iron phthalocyanine was labelled with Fe-59 and the dissolving time of the complexed Fe ions measured; the results were compared with the potential time behaviour of the oxygen cathodes. To check the interactions between phthalocyamine catalysts and carbon carrier, Moessbauer spectroscopy was used. The evidence obtained suggest the application of isotope technical methods to an ever greater extent than up to now in fuel cell and battery research.

3372 Electrochemical investigations in the system manganese—tungsten—oxygen. Trumm, A. Munich; Munich (16 Dec 1971). 113p. INIS.(In German).

56 tabs.; 54 refs.; with figs. Available from ZAED.

Thesis (Ph. D.).

In the concentration triangle tungsten - manganese - oxygen electro-chemical partial pressure-measurements were made. The oxygen partial pressure was determinded via electromotive power generated by a oxygen-ion-conducting solid cell. Special attention was paid to the measurements in the intersection MnO-WO_3. The line of the oxygen partial pressure curve against the composition made it possible to demarcate the concentration area of homogene, non-stoichiometric mixture phase which exists in this intersection. This area reaches at 1,000 degrees C from 40 mole per cent WO_3 to 50 mole per cent WO_3. At 700 degrees C it appears to shrink to 40 mole per cent.

PHOTOVOLTAIC CONVERTERS

REFER ALSO TO CITATION(S) 2579, 2595, 2596, 2598, 2600

3373 Photovoltaic cell with enhanced power output. Adler, A.D. (to New England Inst., Inc.). US Patent 3,935,031. 7 May 1973. vp.

An article of manufacture comprising a photovoltaic cell having a layer of at least one porphyrinic compound deposited on an exposed semiconductor surface thereof, said layer being at least as thick as a monomolecular layer of said porphyrinic compound is described.

POWER CYCLES

OTHER

3374 Thermo-mechanical generator. Cooke-Yarborough, E.; Franklin, E.; Geisow, J.; Howlett, R.; West, C. (Atomic Energy Research Establishment, Harwell, Eng.). pp 643-649 of In Power sources 5. Collins, D.H. (ed.). New York; Academic Press Inc. (1975).

From 9. international power sources symposium; Brighton, UK (17 Sep 1974).

See CONF-740908—.

This paper reports results of research at Harwell on thermal energy conversion, which has led to the successful development of an efficient heat engine/alternator system (Cooke-Yarborough, 1967) capable of delivering several tens of watts of alternating current. It has no rotating or sliding surfaces, so requires no lubrication, and is believed to be capable of operating continuously for many years without wear or need for attention. It is capable of using heat from a variety of sources and is self-starting on application of heat. An electrically heated laboratory model delivers 25 W ac with an overall conversion efficiency of 13 percent.

SUPERCONDUCTING GENERATORS

REFER ALSO TO CITATION(S) 2656

ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION

REFER ALSO TO CITATION(S) 3337, 3346, 3354, 3358

3375 (UCRL—52000-76-7) **Energy and technology review.** Selden, R.W.; Bathgate, M.B.; Crawford, R.B.; Cummings, K.L.; Prono, J.K. (eds.). (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jul 1976. Contract W-7405-Eng-48. 25p. Dep. NTIS $3.50.

A separate entry was prepared for each of the four sections of the report. One item, Forecasting the World's Crude Oil Supply, by I.Y. Borg, is included for EAPA.

BUILDINGS

REFER ALSO TO CITATION(S) 2615, 3325, 3352, 3353

RESIDENTIAL

REFER ALSO TO CITATION(S) 3328, 3349, 3356

3376 (BNL—21722) **Seasonal performance and cost factors of oil or gas-fired boilers and furnaces.** Berlad, A.L.; Batey, J.; Hoppe, R.; Salzano, F.J. (Brookhaven National Lab., Upton, N.Y. (USA)). Aug 1976. Contract E(30-1)-16. 9p. Dep. NTIS $3.50.

The cost effective performance of an oil- or gas-fired furnace for residential space heating and/or domestic hot water systems is examined on a theoretical basis. Numerical expressions are derived for the Seasonal Performance Factor and Seasonal Cost Factor for a given boiler/furnace design and can be compared with experimental data on fuel consumption and boiler/furnace efficiency. (LCL)

3377 (PB—248292) **Guidelines for residential oil-burner adjustments. Oil-burner adjustment procedures to minimize air pollution and to achieve efficient use of fuel.** Locklin, D.W.; Barrett, R.E. (Battelle Columbus Labs., Ohio (USA)). Oct 1975. 26p. (EPA—600/2-75-069-a). NTIS.

These guidelines contain recommended procedures for adjusting residential oil burners to minimize air pollution and for efficient fuel use. They are intended for use by skilled service technicians in adjusting burners, and as an aid to service managers engaged in training service technicians. In addition to recommended steps for burner adjustment, the guidelines also include appendixes of background material on pollutants of main concern, field-type instruments and significance of measurements, and emission characteristics of residential oil burners.

OFFICE

REFER ALSO TO CITATION(S) 3357

SCHOOL

REFER ALSO TO CITATION(S) 3357

COMMERCIAL

REFER ALSO TO CITATION(S) 3348, 3357

TRANSPORTATION AND PROPULSION

REFER ALSO TO CITATION(S) 3350, 3409

LAND AND ROADWAY

REFER ALSO TO CITATION(S) 3324, 3397, 3432, 3835

3378 **Polymer delineation system.** Woolman, S.; Steinberg, M. (to Energy Research and Development Administration). US Patent Application 589,804. 24 Jun 1975. 4p.

A delineation system (traffic lane lines) for highways is described in which polymerizable substances are applied to existing or newly prepared highway pavements. The substances would contain a suitable pigment and may incorporate reflective elements.

INDUSTRY

REFER ALSO TO CITATION(S) 3347, 3352

3379 (NP—21143) **Energy use and conservation in the processing works of the New Zealand meat industry.** Pearson, R.G.; Pilling, R.G. (Lincoln Coll., Canterbury (New Zealand)). Dec 1975. 87p. Dep. NTIS (US Sales Only) $5.00.

Details on the consumption of fuels and electricity by the New Zealand meat freezing industry are presented. The meat freezing process begins with the slaughter of live animals and ends with the production of frozen meats, hides, and all non-edible by-products. Each step in the process is examined for energy conservation possibilities. After examining coal, petroleum, and electric power consumption data for 1973/74 it is concluded that fuel consumption will increase 1 percent per year, and electric power consumption will increase from 4 to 8 percent per year due to increased meat demand; that the efficiency of equipment used at various stages in meat processing should be monitored and improved; and that the use of heat recovery units should be investigated and promoted. (LCL)

EQUIPMENT AND PROCESSES

REFER ALSO TO CITATION(S) 3328, 3390, 3401

WASTE HEAT UTILIZATION

3380 (BM-RI—7929) **Thermal energy recovery by basic oxygen furnace offgas preheating of scrap.** Drost, J.J.; Daellenbach, C.B.; Mahan, W.M.; Hill, W.C. (Bureau of Mines, Twin Cities, Minn. (USA). Twin Cities Metallurgy Research Center). 1974. 8p. Bureau of Mines, Washington, DC.

The feasibility of basic oxygen furnace (BOF) offgas heat recuperation by preheating scrap was investigated on a pilot plant scale by the Bureau of Mines. In this study, offgases generated during the oxygen blowing of a molten pig iron and scrap charge were passed through a static bed of shredded auto scrap. Scrap quantities varying from 100 to 180 lb and representing from 22 to 40 percent of the 450-lb BOF metallic charge were preheated in this manner. Average scrap bed temperatures of 1650°F for 100 lbs of scrap and 1150°F for 180 lb of scrap have been achieved during the blows. As compared to cold scrap used in the normal BOF practice, it was found that by preheating scrap, usage could be increased by 43 percent. The thermal energy recovered by this preheating method can account for up to 44 percent of the energy necessary to melt the scrap.

RECYCLING

3381 (CONF-7505106—1) **Recycling: an example from the glass industry.** Knoche, H. (Rationalisierungs-Kuratorium der Deutschen Wirtschaft (RKW) e.V., Frankfurt am Main (Germany, F.R.). Rationalisierungsgemeinschaft Verpackung (RGV)). 1975. 16p. (In German). Dep. NTIS (US Sales Only) $3.50.

From Symposium on recycling) an example from the glass industry; Dusseldorf, German, Federal Republic of (F.R. Germany) (13 May 1975).

The experience of the West German glass industry in a glass recycling program is reviewed. The effort to reduce the amount of new raw materials consumed in producing glass containers involved both reducing the weight of fabricated containers and using recycled glass gathered by individuals and civic groups. The cooperation which the glass industry received and savings which resulted from the recycling program are viewed as an example for other industries to follow. (LCL)

3382 (CONF-7505106—2) **Recycling of municipal wastes in Sweden.** Flory, I. (Rationalisierungs-Kuratorium der Deutschen Wirtschaft (RKW) e.V., Frankfurt am Main (Germany, F.R.). Rationalisierungsgemeinschaft Verpackung (RGV)). 1975. 10p. (In German). Dep. NTIS (US Sales Only) $3.50.

From Symposium on recycling) an example from the glass industry; Dusseldorf, German, Federal Republic of (F.R. Germany) (13 May 1975).

The Swedish experiment in which 150,000 households are engaged in pre-sorting household garbage in order to recover raw materials such as glass, paper, and tinplate is described. Every Swede produces about 300 kg of household refuse per year from which 50 kg of paper and 35 kg of glass and metal are recoverable. Results so far show that citizens willingly participate in the program because it makes sense to them. (LCL)

3383 (CONF-7505106—4) **Possibilities of separating household wastes.** Hoberg, H.; Schulz, E. (Rationalisierungs-Kuratorium der Deutschen Wirtschaft (RKW) e.V., Frankfurt am Main (Germany, F.R.). Rationalisierungsgemeinschaft Verpackung (RGV)). 1975. 28p. (In German). Dep. NTIS $4.00.

From Symposium on recycling) an example from the glass industry; Dusseldorf, German, Federal Republic of (F.R. Germany) (13 May 1975).

The need for recycling household wastes in order to save raw materials and to protect the environment is discussed. Methods used in the USA and in West Germany to separate glass,

aluminum, plastics, iron scrap, nonferrous metals, and paper from household wastes are described. The experimental facility in Aachen which uses magnetic, optical, pneumatic, hydraulic, and cyclone separators to recover these substances from garbage is described. (LCL)

3384 (CONF-7505106—5) **Environment and packaging with consideration of the recycling of packaging wastes.** Moser, W. (Rationalisierungs-Kuratorium der Deutschen Wirtschaft (RKW) e.V., Frankfurt am Main (Germany, F.R.). Rationalisierungsgemeinschaft Verpackung (RGV)). 1975. 18p. (In German). Dep. NTIS (US Sales Only) $3.50.

From Symposium on recycling) an example from the glass industry; Dusseldorf, German, Federal Republic of (F.R. Germany) (13 May 1975).

The subjects discussed include: kinds of wastes, particularly packaging wastes and presently used waste disposal methods; the quantity of these wastes and their recycling; can the problems of recycling, processing, disposal, and reuse of municipal, especially household, wastes be solved; and effective beneficial solutions for eliminating adverse environmental effects caused by packaging wastes. Tabulated data are presented on material consumption and waste production by glass, plastic, metallic, paper, and other material packaging in US, France, West Germany; percent of packaged wastes attributable to each of these materials as used in those three countries plus England and Switzerland; the environmental effects and costs of the wastes produced; and the comparative cost of handling, processing, recycling, reusing, disposing, or burning packaging wastes. (LCL)

3385 (CONF-7505106—6) **Practice of waste glass recovery.** Knoche, H. (Rationalisierungs-Kuratorium der Deutschen Wirtschaft (RKW) e.V., Frankfurt am Main (Germany, F.R.). Rationalisierungsgemeinschaft Verpackung (RGV)). 1975. 20p. (In German). Dep. NTIS (US Sales Only) $3.50.

From Symposium on recycling) an example from the glass industry; Dusseldorf, German, Federal Republic of (F.R. Germany) (13 May 1975).

Based on the slogan "old glass is not waste, but raw material" the glass container industry of West Germany is promoting glass recycling. Programs for encouraging individuals, civic groups, and communities to collect used glass are described. (LCL)

ELECTRIC POWER

REFER ALSO TO CITATION(S) 3352, 3353

BUILDINGS

REFER ALSO TO CITATION(S) 3356, 3357

INDUSTRY

3386 (GAT-E—202) **Challenge to those in instrumentation related to productivity and measuring power usage.** Steinhauer, H. Jr. (Goodyear Atomic Corp., Piketon, Ohio (USA)). 29 Jun 1976. Contract E(33-2)-1. 19p. (CONF-761007—3). Dep. NTIS $3.50.

From Conference on productivity through instrumentation and control; Houston, Texas, United States of America (USA) (10 Oct 1976).

With the development of micro-modules and micro-processors, those in instrumentation are challenged to employ the principles of the Incremental Power Demand Computer (IPDC) to better utilize electric power in many applications. The IPDC was developed at the Portsmouth Gaseous Diffusion Plant in 1959 for measuring 2,000,000 kW demand and to better utilize electric power in the production of enriched uranium. Two generations of the instruments have been used during the past 17 years to aid in the measurement and control of power usage and will be similarly used in the future when the plant load will be increased to 2,260,000 kW. The second generation IPDC measures in and out flow on 26 meters to accurately account for transfer of power through the plant substations from one power system to the other, as well as for the power utilized by the plant. This system also prints out the hourly load on each of the meters and is utilized for calculating the multi-million dollar electric power bill each month. The second generation IPDC uses solid-state components mounted on printed circuit boards for reliability. Pulses from the special pickups in the billing watt-hour meters are used by the IPDC to determine and display accurate plant power usage every six minutes. Application of these IPDC principles to many existing watt-hour meters would result in the better utilization of electric power.

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 3803, 3956, 3957, 3958, 3959, 3960, 3961

3387 **Position statement on effective hazardous waste mangement (non-radioactive).** *Fed. Regist. (Wash., D.C.);* **41**: No. 161, 35050-35051(18 Aug 1976).

From Environmental Protection Agency.

Pursuant to section 204(b)(1) of the Solid Waste Disposal Act, as amended, the Administrator may issue advisory guidance and recommendations related to the disposal of waste materials. This issuance is one of a series to be published by the Agency. These guides represent the best technical and policy counsel of the Agency at the present time, and are based on work conducted over the past four years by the Agency. These guidance documents do not have regulatory or standard-setting status for anyone, including Federal agencies. This position statement contains fundamental concepts which the Agency believes should govern the management of non-radioactive hazardous waste and should form the basic foundation for effective State programs addressing this subject. Although State and local government officials and Federal agencies are the primary audience for this position statement, it should be of interest to hazardous waste generators, the waste treatment and disposal industry and concerned citizens as well. Many of the principles contained in this statement may well be applicable to a comprehensive strategy at the State level to plan for and assure environmentally sound management of all wastes.

ADVANCED AUTOMOTIVE PROPULSION SYSTEMS

INTERNAL COMBUSTION ENGINES

REFER ALSO TO CITATION(S) 3405

3388 (UCRL—78280) **Flash radiographic technique applied to fuel injector sprays.** Bahl, K.L.; Vantine, H.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jun 1976. Contract W-7405-eng-48. 17p. (CONF-760914—4). Dep. NTIS $3.50.

From American Society for Nondestructive Testing Flash X-Ray symposium; Houston, Texas, United States of America (USA) (27 Sep 1976).

A flash radiographic technique, using 50 ns exposure times, was used to study the pattern and density distribution of a fuel injector spray. The experimental apparatus and method are described. An 85 kVp flash x-ray generator, designed and fabricated at the Lawrence Livermore Laboratory, was utilized. Radiographic images, recorded on standard x-ray films, were digitized and computer processed.

SPARK-IGNITION

REFER ALSO TO CITATION(S) 3402, 3403, 3408, 3432, 3442, 3446

3389 **Stratified-combustion type internal combustion engine with pre-combustion-chamber.** Goto, K. (to Toyota Jidosha Kogyo Kabushiki Kaisha). US Patent 3,967,611. 6 Jul 1976. Priority date 9 Aug 1973, Japan. 6p.

A stratified-combustion type internal combustion engine has a rich fuel-air mixture passage and an air passage both open into the main combustion chamber. A pre-combustion chamber is located adjacent to the main combustion chamber and has a connecting port to the main combustion chamber adjacent to the opening of the rich fuel-air mixture passage. The rich fuel-air mixture is supplied to and burnt within the pre-combustion chamber.

TURBINE

REFER ALSO TO CITATION(S) 3398

3390 (COO—2630-15) **Automotive gas turbine ceramic regenerator design and reliability program. Progress report, April 1, 1976—June 30, 1976.** Cook, J.A.; Fucinari, C.A.; Lingscheit, J.N.; Rahnke, C.J. (Ford Motor Co., Dearborn, Mich. (USA)). Jul 1976. Contract E(11-1)-2630. 125p. Dep. NTIS $5.50.

The primary objective of the ERDA/Ford Ceramic Regenerator Design and Reliability Program is to develop ceramic

regenerator cores that can be used in passenger car gas turbine engines, Stirling engines, and industrial/truck gas turbine engines. Specific durability objectives are defined as achieving a B_{10} life of 10,000 hours on a truck/industrial gas turbine engine duty cycle. Previous reports, under this contract, summarized operating experience on lithium aluminum silicate (LAS) ceramic regenerator cores obtained at Ford Motor Company. The primary cause of failure of these regenerators was determined to be chemical attack of the LAS material. Improved materials and design concepts aimed at reducing or eliminating chemical attack were placed on durability test in Ford 707 industrial gas turbine engines late in 1974. Results are described of 2700 hours of turbine engine durability testing accumulated during the second quarter of 1976. Two materials, aluminum silicate and magnesium aluminum silicate continue to show promise toward achieving the durability objectives of this program. Regenerator cores made from aluminum silicate show no evidence of chemical attack damage after 5000 hours of engine test.

3391 (COO—2749-T6) **Baseline Gas Turbine Development Program sixth quarterly progress report.** Wagner, C.E. (Chrysler Corp., Detroit, Mich. (USA)). 30 Apr 1974. 118p. Dep. NTIS $5.50.

Progress is reported for a program to demonstrate by 1976 an experimental gas turbine powered automobile which meets the 1976 Federal Emissions Standards, has significantly improved fuel economy, and is competitive in performance, reliability, and potential manufacturing cost with the conventional piston engine powered, standard size American automobile. Engines were built to replace those originally loaned to the Program. Efforts to identify and correct a general power deficiency were generally successful. The third baseline vehicle was built and checked out. Baseline vehicle emissions, performance, fuel consumption, and noise tests were run. Chrysler's proprietary linerless insulation showed no significant distress following 300 hours of engine endurance testing. An improved elastomeric drive for ceramic regenerators was developed on the regenerator rig. Preparations are being made for engine testing. The Ai Research engine simulation model is operational and control system concepts are being studied. Operation of the preprototype fuel system was verified on an engine. All other key preprototype system elements were bench checked. Variable inlet guide vane testing and development and torque converter lock-up evaluation tests are in process. A free rotor engine arrangement for vehicle evaluation and development is being built. Initial specifications were completed for a 122 horsepower, compact vehicle upgraded engine. NASA completed initial specifications for the gas generator aerodynamics. Overall engine and engine housing layout studies are being made.

3392 (COO—2749-T8) **Baseline Gas Turbine Development Program eighth quarterly progress report.** Schmidt, C.E. (Chrysler Corp., Detroit, Mich. (USA)). 31 Oct 1974. 94p. Dep. NTIS $5.00.

Progress is reported for a program to demonstrate by 1976 an experimental gas turbine powered automobile which meets the 1978 Federal Emissions Standards, has significantly improved fuel economy, and is competitive in performance, reliability, and potential manufacturing cost with the conventional piston engine powered, standard size American automobile. Major preparations for engine heat balance tests by NASA were completed. EPA laboratories completed Baseline vehicle emissions, noise, and odor tests. Assembly of the program endurance engine is nearing completion. Test cell evaluation of the government furnished combustor (Solar) verified steady state emissions to be extremely low. Initial engine tests of Vendor A ceramic regenerator cores with an elastomeric drive verified performance predictions. Efforts towards developing a non-nickel oxide regenerator seal show extreme sensitivity to porosity differences between cores of different suppliers. All three preprototype integrated control systems were built. Modifications are being worked out to achieve a stable low speed operation. Two prototype compressor turbine wheels made from the reuseable pattern process are being inspected and processed for testing. The engine housing modified for operation at higher cycle temperatures and pressures was received. The baseline engine converted to free rotor is completing test cell check out. The modified vehicle is ready for engine installation. The upgraded engine characterization was updated to include the latest information on V.I.G.V., rotors, and bearings. The upgraded engine housing is being modeled physically and analytically for design and stress studies. An accessory drive system for the upgraded engine was selected, and a final layout is in process.

3393 (COO—2749-T9) **Baseline Gas Turbine Development Program ninth quarterly progress report.** Schmidt, C.E. (Chrysler Corp., Detroit, Mich. (USA)). 31 Jan 1975. Contract E(11-1)-2749. 229p. Dep. NTIS $8.00.

Progress is reported for a program to demonstrate by 1976 an experimental gas turbine powered automobile which meets the 1978 Federal Emissions Standards, has significantly improved fuel economy, and is competitive in performance, reliability, and potential manufacturing cost with the conventional piston engine powered, standard size American automobile. NASA completed the first phase of their baseline engine heat balance tests, and an upgraded engine compressor is being scaled for test. EPA completed their report on vehicle tests including emissions and vehicle performance, and a new endurance engine is on test. Significant development progress was made on both fixed and variable geometry combustors. After 45 hours of engine operation with Vendor A ceramic regenerator, no significant deterioration of the matrix, seals, or elastomeric mount was encountered. Ceramic regenerator stress analysis has commenced. Additional developments in non-nickel oxide regenerator rubbing seals are encouraging. The first preprototype integrated control system is in vehicle operation. Control adaptation for variable inlet guide vanes and water injection is progressing. AiRefrac turbine wheels were verified dimensionally and are being processed for engine testing. Water injection tests with a four nozzle system were run, and additional performance documentation of variable inlet guide vanes was obtained. Linerless insulation is on test in the free rotor engine, the new endurance engine, and a performance engine. The free rotor engine completed test cell checkout and was installed in a vehicle. Vehicle checkout, including a preprototype integrated control, is underway. Detailed specifications of the upgraded engine were written.

ROTARY

REFER ALSO TO CITATION(S) 3406

STIRLING CYCLE

REFER ALSO TO CITATION(S) 3390

ELECTRIC-POWERED SYSTEMS

REFER ALSO TO CITATION(S) 3256, 3257, 3272, 3299, 3308, 3309

3394 **Linear synchronous motor powered vehicle.** Maki, N.; Suzuki, K. (to Hitachi, Ltd.). US Patent 3,960,090. 1 Jun 1976. Priority date 15 Aug 1973, Japan. 10p.

A vehicle powered by a linear synchronous motor is described. The linear synchronous motor comprises a series of field poles fitted on the vehicle body along its total length and a series of magnetic devices being provided along a track on the ground facing these field poles and developing a travelling magnetic field. A driving force developed between these field poles and the magnetic devices causes the vehicle to move. Such a linear synchronous motor powered vehicle has a problem when securing proper and satisfactory places to mount the necessary equipment of the vehicle. The problem arises from the peculiar construction thereof that a plurality of field poles are disposed along the entire length of the vehicle body. A satisfactory mounting of the apparatus may be attained by a unique arrangement of the field poles, without making the vehicle body large in size or providing discomfort to the passengers.

3395 **Lead—oxygen dc power supply system having a closed loop oxygen and water system.** Britz, W.J.; Boshers, W.A.; Kaufmann, J.J. US Patent 3,964,928. 22 Jun 1976. Filed date 27 Dec 1974. 8p.

An electrical power system is described for supplying dc power to electrically motorized vehicles, emergency standby sources, and the like. A lead-oxygen battery cell used as a source of dc power includes a positive charging grid, a conventional negative electrode, a positive discharging electrode, and a teflon membrane member coated with a catalyst contained in an atmosphere of oxygen which is admitted to the cell through the teflon membrane. Oxygen is given off during the charging cycle and is compressed in a storage tank for re-use during each duty cycle providing a closed system wherein contamination is minimized and a long-life cycle can result.

FLYWHEEL PROPULSION

REFER ALSO TO CITATION(S) 3253

VEHICLE DESIGN FACTORS

ENGINE SYSTEM

REFER ALSO TO CITATION(S) 3389, 3410, 3411, 3413, 3433

3396 System for utilizing waste heat of an internal combustion engine. Gamell, J.A. (to Joseph Gamell Industries, Inc.). US Patent 3,948,235. 31 Mar 1975. Filed date 31 Oct 1973. vp.

Apparatus is described for utilizing waste heat from an internal combustion engine to operate a supercharger. The supercharger has an impeller situated in an air intake conduit of an internal combustion engine, and a turbine, provided with a fluid inlet port and outlet port, drives the supercharger. The fluid is vaporized by the exhaust gas heat, drives the turbine, and then is condensed. The apparatus is completely separated from the fuel system and has a non-combustible fluid.

3397 Fuel saving apparatus. Donovan, J.W. US Patent 3,960,133. 1 Jun 1976. Filed date 1 Mar 1974. 6p.

Apparatus is disclosed which is useful for conserving fuel and which comprises a means for preventing or controlling the opening of a valve, commonly called a butterfly valve, of a carburetor, beyond a pre-selected point whereby the flow of fuel into the intake manifold is controlled. Disclosed more particularly is an improved gasket for insertion between the carburetor and intake manifold of a vehicle.

3398 Gas turbine engine. Pearce, B.R.; Powell, W.J. (to Rolls-Royce (1971) Ltd.). US Patent 3,959,966. 1 Jun 1976. Priority date 5 Oct 1973, United Kingdom of Great Britain and Northern Ireland (UK). 6p.

A gas turbine engine having an annular combustion chamber that has an outlet duct to turbine entry vanes is described. An extension of the combustion chamber is connected to a radially outer wall of the duct at a position adjacent to the downstream end of the vanes. The wall is covergent in the downstream direction, the extension is connected to the wall at a location upstream of the downstream extremity, and cooling air passages are arranged to lead cooling air to the junction so that on heating of chamber in operation the extremity expands radially outwardly and in the downstream direction thereby to make sealing engagement with an adjacent extremity of a shroud ring of the vanes.

3399 Fuel enrichment and hot start control apparatus in a fuel control. Paduch, S.R.; Hansen, K.P. (to United Technologies Corp.). US Patent 3,964,253. 22 Jun 1976. Filed date 3 Jul 1975. 6p.

A description is given of a fuel control which utilizes power plant speed and turbine inlet temperature as parameters for controlling the fuel enrichment and hot start protection of the power plant during starting.

3400 Low velocity gas turbine with exhaust gas recycling. St. John, W.A. US Patent 3,964,254. 22 Jun 1976. Filed date 12 May 1975. 10p.

A description is given of a low velocity high torque gas turbine, which uses the Brayton Cycle, and has a high velocity compressor with a separation of the working fluid into two columns, one external for cooling and the other internal for primary fuel injection and combustion. A feature is the recycling of a proportion of the combustion gases that is then combined with the external column of heated cooling air for secondary fuel injection and combustion. The primary and secondary combustion fluids are mixed, the diffused and separated column of cooling air being advantageously employed to supply an excess of oxygen in the working fluid to adequately support combustion. The tubular turbine shaft for recycling combustion gases, the working fluid distributor that combines the primary and secondary working fluids, and the speed increasor for the compressor all characterize this invention.

3401 Energy conservation apparatus for an electric vehicle. Williams, T.O.; Grant, A.F. (to Towmotor Corp.). US Patent 3,964,260. 22 Jun 1976. Filed date 27 May 1975. 8p.

A hydraulic accumulator is provided in the hydraulic system of an electric vehicle, such as a lift truck, for conserving its battery power by minimizing the frequency of energy draining pump start-ups during operation. Pressurized fluid stored in such accumulator is utilized for powering any of the various hydraulically actuated work elements employed on the vehicle when the pump is not being run. The system further provides for automatically starting and stopping the pump to keep the pressure in the accumulator within a predetermined operating range and for starting the pump when required to achieve the desired actuation of a particular work element.

3402 Six cycle combustion and fluid vaporization engine. Tibbs, R.C. US Patent 3,964,263. 22 Jun 1976. Filed date 31 Dec 1974. 6p.

A reciprocating piston engine is described of the type including a piston reciprocal in a cylinder toward and away from an expansion chamber at one end of the cylinder and also provided with intake and exhaust valves openable and closable in timed sequence with reciprocation of the piston. The valves are closed during the compression and power strokes of the piston, and the exhaust valve is opened during the third stroke of the piston toward the expansion chamber. During the fourth stroke of the piston, a readily vaporizable liquid is injected into the expansion chamber under pressure for flashing into a vapor upon being heated by the residue heat of combustion in the expansion chamber, and during the fifth and sixth strokes of the piston the exhaust and intake valves, respectively, are open to exhaust the vaporized liquid therefrom and intake a fresh combustible mixture of air and fuel into the expansion chamber and cylinder prior to compression of the mixture on the next stroke of the piston toward the expansion chamber. Also, the expansion chamber and piston include a plurality of fin portions for absorbing considerable quantities of heat during the combustion power stroke and the combustion gas exhaust stroke of the engine whereby sufficient residue of heat is retained within the combustion chamber for substantially instantly flashing the vaporizable liquid injected thereinto during the fourth stroke of the piston into a vapor.

3403 High compression internal combustion engine using a lean charge. Nakamura, N.; Baika, T. (to Toyota Jidosha Kogyo Kabushiki Kaisha). US Patent 3,964,452. 22 Jun 1976. Priority date 4 Aug 1973, Japan. 10p.

A spring-loaded piston is slidably arranged in an auxiliary chamber opening into the combustion chamber of an internal combustion engine. The spring-loading of the piston is preset so that the piston retracts at a certain high pressure attained during the combustion process, thereby increasing the combustion chamber volume. This enables higher compression ratios to be used than is otherwise possible.

3404 Hydrokinetic device. Cottrell, H.L.; Mamo, A.C. (to Power Control, Inc.). US Patent 3,965,680. 29 Jun 1976. Filed date 14 Jan 1975. 10p.

A hydrokinetic device is comprised of a fluid containing housing and unique relatively rotatable wheel means, including an impeller wheel connected to an input shaft and a turbine wheel connected to an output shaft. With the addition of a stator wheel, the device may provide torque multiplication between the shafts, or without the stator may be used to couple the shafts together. The wheel means is sized and arranged so that in one sequential pair of wheels the entrance edge of one of the wheels is spaced apart from the exit edge of the adjacent wheel a distance generally equal to or greater than the smallest maximum width of one of the wheels, and so that the heads generated by rotation of the wheels are predominantly additive and do not cause potentially destructive negative counter heads opposing the impeller flow. The conical configuration of wheel means with parallel edges especially lends itself to achieving such desired arrangement. Thus, the present hydrokinetic device prevents the generation of the destructive instability associated with hydrokinetic torque multipliers operated at variable fill, is capable of quickly being emptied and filled to achieve hydraulic neutral, and may be operated at various levels to achieve variable power absorbing and transmitting capacity.

3405 Internal combustion engine and turbosupercharger therefor with heat pipe for intake mixture heating. Wyczalek, F.A.; Harned, J.L.; Smith, O.M. (to General Motors Corp.). US Patent 3,965,681. 29 Jun 1976. Filed date 30 Jun 1975. 6p.

An internal combustion engine is provided with a turbosupercharger including: a vaned rotatable compressor wheel arranged in an inlet passage to compress inlet mixture for delivery to the engine combustion chamber; a vaned turbine wheel arranged in an exhaust passage to be driven by the flow of engine exhaust gases; a shaft interconnecting the turbine and compressor wheels for rotation together on a common axis; and vaporizable fluid heat transfer means in the form of a heat pipe extending through the shaft between the turbine and compressor wheels for transferring exhaust heat from the turbine wheel to the compressor wheel to heat the engine inlet mixture.

3406 Rotary piston engine equipped with an improved air or fuel injection opening. Sasaki, Y. (to Toyota Jidosha Kogyo Kabushiki Kaisha). US Patent 3,967,592. 6 Jul 1976. Priority date 22 Jul 1974, Japan. 4p.

An improved air or fuel injection opening is described for a rotary piston engine having a trochoidal inner surface of a center housing and an eccentrically rotating polygonal rotor. The air or

fuel injection opening provided in a side housing wall is confined within a region limited so as to be outside of an outer envelope of traces of a side seal and inside an outer corner seal, with the opening having a contour smaller than that of the corner seal.

3407 Intake vacuum controlled manifold vacuum spoiler. Dolfi, J.J. Sr. US Patent 3,967,605. 6 Jul 1976. Filed date 21 May 1974. 6p.

A valve body is described having a bore defining an air inlet at one end and including a diametrically enlarged counterbore at the other end. The outer end of the counterbore is closed by means of a removable end wall having a small diameter opening, and a piston is slidable in the counterbore and includes a shank portion coaxial therewith longitudinally reciprocal in the bore. A compression spring is disposed between the end wall and the piston and yieldingly biases the latter toward a position seated in the inner end of the counterbore. The valve body includes a lateral outlet bore or passage whose inner end opens into the first-mentioned bore intermediate the opposite ends thereof, and the outer end of the lateral bore has one arm of a tubular T-fitting secured therein, the other two arms of the tubular T-fitting being adapted to be interposed in a positive crankcase ventilating hose. Further, a vent passage communicates the inner end of the counterbore with the lateral bore, and the small diameter passage or bore formed through the end wall is adapted to be communicated with a source of manifold vacuum of an internal combustion engine, whereby in response to increases in manifold vacuum, the piston will be drawn toward the end wall against the biasing action of the compression spring in order to move the end of the piston shank remote from the piston out of registry with the inner end of the lateral bore and thereby establish communication between the inlet end of the bore in which the piston stem is reciprocal with the inner end of the lateral bore.

3408 Internal combustion engine fed with a stratified double charge. Henault, C.; Cochard, P. (to Regie Nationale des Usines Renault). US Patent 3,970,054. 20 Jul 1976. Priority date 21 Feb 1974, France. 6p.

An internal-combustion engine fed with a stratified charge is comprised of an inlet leading into a combustion chamber for feeding a main charge of a lean mixture of a first fuel and air, and an injection device for injecting a second fuel into an ignition zone of the combustion chamber in an amount such that the mixture of the second fuel and the air contained in the lean mixture, in the ignition zone at the time of ignition, attains the level of the ignition richness of the second fuel. Thereby, the second fuel undergoes ignition and combustion and effects flame propagation to produce ignition of the first fuel. A holder with a ball valve protects the fuel injector of the injection device by obturating the injector at the end of the compression stroke and during ignition and the subsequent expansion stroke.

3409 Conservation of energy heater. Keeling, B.E.; Hawkins, H.R. US Patent 3,970,247. 20 Jul 1976. Filed date 7 Nov 1974. 6p.

An auxiliary air preheater is described for use in prewarming interiors of vehicles having engine preheating means employing a heated fluid for prewarming the engine prior to operation of the vehicle. The auxiliary heater includes an insulated housing surrounding a section of conduit employed for conveying heated fluid employed in the engine preheating operation. Air is circulated through the housing in contact with the heated fluid conduit and is blown into the vehicle compartment. Air may be returned from the vehicle compartment through the auxiliary air preheater housing for recirculation through the passenger compartment.

EMISSION CONTROL

REFER ALSO TO CITATION(S) 3400, 3403, 3407, 3444, 3445, 3830, 3831

3410 System to prevent pollution of atmosphere. Knapp, E.M.; Nesbitt, S.J. US Patent 3,948,224. 22 Apr 1970. vp.

A fuel system for an internal combustion engine is described in which an evolver thermally cracks the liquid fuels into gas. The amount of fuel furnished to the evolver is controlled by a valving system dependent on the operating rate of the engine. (PMA)

3411 Internal combustion engine with pollution control arrangement. Helbling, E. US Patent 3,948,233. 7 Mar 1974. vp.

A closed casing, attached to the exhaust manifold, contains liquid automotive fuel and means for removing the pollutants from the combustion gases. A depressurizing-baffle forces the combustion gases to travel through the liquid fuel, and the resulting fuel enriched gases are returned to the engine intake for mixing with air and additional fuel. The fuel in the closed casing is automatically replenished. (PMA)

3412 Anti-pollution device for treating exhaust from internal combustion engines. Davidson, G.L. US Patent 3,948,046. 23 Sep 1974. Filed date 21 Feb 1973. vp.

A catalytic converter for an internal combustion engine is described. The device provides for mixing the exhaust gases with oxygen and for cooling them on heat transfer surfaces of coils containing a circulating fluid coolant. Baffles in the housing cause turbulent flow of the exhaust gases to maximize contact, and a metal catalyst surface oxidizes the gaseous components. (PMA)

3413 Exhaust gas sensor operational detection system. Luchaco, D.G. (to Bendix Corp.). US Patent 3,948,228. 6 Nov 1974. vp.

A fuel injection system is electrically controlled by an exhaust gas sensor which provides voltage signals dependent on exhaust gas composition. The feedback network includes a waveshape transition detector, a multivibrator, a test control circuit, a transition interval indicator, and an indicator level sensor. (PMA)

3414 Inter-Industry Emission Control Program-2 (IIEC-2) progress report No. 1. Warrendale, PA; Society of Automotive Engineers, Inc. (Jan 1975). vp. (NP—20960).

Eight papers are presented which resulted from a cooperative research program by eleven petroleum and automotive industries to reduce automotive emissions and improve fuel economy. Topics include: (1) a comprehensive summary of the program; (2) exhaust gas recirculation systems; (3) variations in engine operating parameters; (4) catalytic conversion of exhaust gases; (5) antiknock ratings of automotive fuels; and (6) methanol and gasoline/methanol mixtures as automotive fuels. A separate abstract was prepared for each paper for ERDA Energy Research Abstracts (ERA). (PMA)

3415 Internal combustion exhaust catalytic reactor monitoring system. Neidhard, H.; Linder, E.; Wahl, J.; Schmidt, P.J.; Schoeck, P.A. (to Robert Bosch GmbH). US Patent 3,962,866. 15 Jun 1976. Priority date 31 Jan 1973, German, Federal Republic of (F.R. Germany). 10p.

To supervise operational effectiveness of catalytic reactors included in exhaust emission detoxification systems, an oxygen sensor is located downstream of the reactor to determine oxygen content in the exhaust gases from the internal combustion engine. The oxygen sensor consists of an ion conductive solid electrolyte forming an ion concentration chain and having catalytically inactive contacts and is connected to a detection circuit which provides an output signal in dependence on a signal from the sensor. The output signal operates an alarm or a transducer which interferes with proper engine operation to force the operator to have the reactor repaired. Preferably, two ion conductive chains are used, in a single sensor, or in two sensors, one being exposed to exhaust gases upstream of the catalytic reactor and the other downstream of the catalytic reactor, the output signals being provided to a differentially connected operational amplifier, to balance out extraneous influences.

3416 Secondary air regulating system. Ikeura, K.; Hata, Y. (to Nissan Motor Co., Ltd.). US Patent 3,962,867. 15 Jun 1976. Priority date 27 Jun 1973, Japan. 6p.

A sensor such as an oxygen sensor or a carbon monoxide sensor generates an electrical signal responsive to the oxygen or carbon monoxide concentration in exhaust gases discharged from an exhaust purifying device. Under the control of the electrical signal regulating means, the amount of secondary air to the exhaust purifying devices is regulated.

3417 Exhaust gas purifying system for use in internal combustion engine. Matumoto, N.; Nonoyama, T.; Tomita, T.; Suzuki, Y. (to Toyota Jidosha Kogyo Kabushiki Kaisha). US Patent 3,962,868. 15 Jun 1976. Priority date 24 May 1974, Japan. 22p.

An exhaust gas purifying system is described for use in an internal combustion engine for controlling the air injection into an exhaust manifold and the circulation of exhaust gases from the exhaust manifold to a suction pipe. A negative pressure in the suction pipe varies depending on the running conditions of the engine.

3418 Equipment for exhaust gas detoxification in internal combustion engines. Woessner, G. (to Robert Bosch GmbH). US Patent 3,962,869. 15 Jun 1976. Priority date 4 Sep 1972, German, Federal Republic of (F.R. Germany). 8p.

An insulated heat pipe is provided which transfers heat from the engine's exhaust manifold to an exhaust gas reactor. The heat pipe contains a first zone serving as an evaporation zone and a second zone serving as a transport zone for transporting a working medium between the first zone and a third zone. The third zone

serves as a condensation zone. The heat pipe has an interior capillary tube along which the condensed heat transfer medium flows toward the heat source and within which the vaporized medium flows toward the heat sink.

3419 Catalyst changer for underfloor type catalytic converter. Stahl, J.F. (to Oxy—Catalyst, Inc.). US Patent 3,963,062. 15 Jun 1976. Filed date 16 Aug 1974. 6p.

An improved device for removing and replacing catalyst particles or pellets in an underfloor type catalytic converter is described. The catalytic converter is a purifier installed in the exhaust pipe of an internal combustion engine for the purpose of purifying the emissions. The catalyst changer includes a canister for containing catalyst particles, a conduit for conducting particles from the converter to the canister and vice versa, an eccentrically mounted vibrator to aid in removing particles from the converter and in replenishing the converter with a fresh supply of particles tightly packed in a catalytic bed, and clamping means for rigidly clamping the changer to the catalytic converter during removal and replacement of the catalytic particles. The clamping means is of a construction and magnitude to cause opposed clamping elements to deform the outer skin or surface of the casing of the converter. Such clamping arrangement aids in transmitting the full effect of the vibrational forces created by the vibrator to the catalytic bed of the converter, during replacement of the catalytic particles.

3420 Secondary air supply means of exhaust gas cleaning devices. Yamada, M.; Kitamura, Y. (to Nippondenso Co., Ltd.). US Patent 3,963,444. 15 Jun 1976. Priority date 26 Dec 1970, Japan. 6p.

In an exhaust gas cleaning device having a reaction chamber, a secondary air supply consists of a portion of the exhaust pipe upstream of the reaction chamber which is constructed into a double wall structure having an inner wall defining an exhaust gas passage and an outer wall defining an outer chamber for the passage of secondary air. A valve opens and closes a secondary air supply hole formed in the inner wall and an air releasing hole formed in the outer wall for releasing the secondary air into the atmosphere. A temperature detector is disposed within the reaction chamber and controls the valve. When the internal temperature of the reaction chamber is lower than a predetermined level, the secondary air heated during passage through the outer chamber is supplied into the exhaust gas passage from the secondary air supply hole, while when the internal temperature of the reaction chamber becomes higher than the predetermined level, the secondary air cools the exhaust gases through the inner wall and is released into the atmosphere through the air releasing hole.

3421 Exhaust emission control device of the catalyst type. Koyama, T.; Nanri, M.; Matsui, K.; Hoshino, S. (to Nippondenso Co., Ltd.). US Patent 3,963,445. 15 Jun 1976. Priority date 22 Aug 1972, Japan. 4p.

A device is described comprising exhaust leak preventing means made of a flexible material and mounted between a wall of a container and a catalyst element of a honeycomb structure. The material is disposed in the container to prevent leak of exhausts from an internal combustion engine through a gap between the container wall and the catalyst element before the exhausts are purified. Support means made of pliable metal may be used for holding the exhaust leak preventing means in place and keeping the latter from being dislodged from its position when the container is subjected to forces of impact or vibration.

3422 Catalytic reactor for exhaust gases. Hayashi, Y. (to Nissan Motor Co., Ltd.). US Patent 3,963,447. 15 Jun 1976. Priority date 20 Jul 1971, Japan. 4p.

A catalytic reactor is described for the exhaust gases of a motor vehicle comprising a catalyzer bed through which a pipe extends having one end connected to a secondary-air source. The other end of the pipe is connected to a chamber wherein a simple and economical temperature detector, such as bimetal, is installed. When the temperature of the catalyzer bed exceeds a predetermined value, a valve is electrically activated by an electrical circuit containing the detector, and the exhaust gas bypasses the catalyzer bed.

3423 Two-bed catalytic converter. Hartley, F.J.; Foster, M.R. (to General Motors Corp.). US Patent 3,963,448. 15 Jun 1976. Filed date 21 Nov 1974. 6p.

A description is given of a low profile two-bed catalytic converter including substantially identical top and bottom housing plates and top and bottom catalyst-retaining plates which define an inclined catalyst-containing space. Openings in the retaining plates distribute exhaust flow uniformly through the catalyst-containing space. A partition made up of two spaced plates has uniformly distributed exhaust flow apertures therein and extends through the catalyst-containing space to divide the space into upper and lower catalyst beds. An air distribution means between the partition plates has outlet nozzles for discharging air laterally into streams of exhaust gas flowing through apertures in the air distribution means as the exhaust gases pass from the upper to the lower catalyst bed.

3424 Multi condition relief valve. Fitzgerald, J.B. (to ACF Industries, Inc.). US Patent 3,964,259. 22 Jun 1976. Filed date 6 Aug 1973. 6p.

An automatically-actuated multi-condition relief valve for controlling flow of forced air to a combustion-engine exhaust pipe immediately upstream of an oxidizing catalytic converter is described. The valve body has an inlet, an outlet and a bypass port. A single valve stem has a main valve head for controlling flow between the inlet and outlet ports and a bypass valve head for controlling flow between the inlet and the bypass ports. A valve-stem actuator responds to intake manifold pressure of the combustion engine to allow a biasing means to close the main valve head and open the bypass valve head in response to either a low manifold vacuum—corresponding to a high engine acceleration—or a high manifold vacuum—corresponding to a rapid deceleration. Further, the valve stem actuator responds to intermediate manifold vacuums to open the main valve and close the bypass valve.

3425 Exhaust gas purifier for internal combustion engine. Okano, R.; Bunda, T.; Mizusawa, S.; Morita, A. (to Toyota Jidosha Kogyo Kabushiki Kaisha). US Patent 3,966,443. 29 Jun 1976. Priority date 18 Apr 1973, Japan. 6p.

An exhaust gas purifier for internal combustion engine has a porous filter impregnated with a desired adsorbent or a porous filter made of bulk metal catalyst. Instead of extending perpendicular to the main axial direction of the exhaust pipe, the filter extends axially and is mounted on a metal screen cylinder having a baffle which diverts the flow of exhaust gas toward and through the cylinder and filter. In this manner, the exhaust gas flows axially into the screen cylinder and then passes radially through the filter to a second flow passage which is connected to the purifier outlet. Very low back pressure is obtained with this arrangement.

3426 Exhaust purifier system. Manfredi, F.A. US Patent 3,967,445. 6 Jul 1976. Priority date 24 Dec 1972, Italy. 8p.

A system is described for purifying heated exhaust gases discharged from an internal combustion engine, a furnace, or the like. The system includes a novel rotating finned tube heat exchanger of generally cylindrical configuration. The exchanger has longitudinally extending conduits which direct the exhaust gases back and forth between opposite end chambers of the heat exchanger. The gases are additionally passed, as required depending upon the type of pollutants they contain, through a series of purification devices which may include a novel afterburner to rid the gases of entrained unburned fuel, one or more water bath devices to cleanse the gases, and a separator to removed unburned compounds.

3427 Exhaust gas purifying system. Tamazawa, T.; Yaguchi, H. (to Nissan Motor Co., Ltd.). US Patent 3,967,929. 6 Jul 1976. Priority date 13 Jan 1973, Japan. 6p.

Air is pumped into the engine exhaust manifold to promote oxidation of unburned remnants in exhaust gas when the temperature in a catalytic converter is below a safe level. The air supply to the exhaust manifold is shut off and air is pumped into the catalytic converter to cool it if the temperature goes above the safe level. The catalytic converter includes a catalytic means, having an outer periphery, which is resiliently supported away from the inner circumference of the converter casing. Upon the catalytic means reaching a predetermined maximum temperature, air is pumped into the annular space located between the outer periphery, which may comprise either a particulate or a monolithic catalyst, and the inner circumference of the casing. The annular space communicates with both an exhaust gas inlet chamber located upstream of the catalytic means and an exhaust gas outlet chamber located downstream of the catalytic means, for cooling the catalyst to prevent degradation.

3428 Exhaust gas cleaning device for internal combustion engine. Noguchi, M.; Sumiyoshi, M.; Mizusawa, S. (to Toyota Jidosha Kogyo Kabushiki Kaisha). US Patent 3,968,645. 13 Jul 1976. Priority date 12 Oct 1973, Japan. 8p.

An exhaust gas cleaning device purifier is described for use in an internal combustion engine of a multicylinder type. A housing is disposed between exhaust ports of a cylinder head and an exhaust pipe, in which a catalyst container is enclosed, the catalyst container consisting of two cylinders between which catalyst is filled. A control valve is provided on the catalyst container for passing a part of exhaust gas through the catalyst; the amount of exhaust gas passed through the catalyst varies in accordance with the conditions of the engine.

3429 Apparatus for purifying exhaust waste gases. Cairns, J.A.; Nelsin, R.S.; Pugh, S.F. (to United Kingdom Atomic Energy Authority). US Patent 3,969,082. 13 Jul 1976. Priority date 30 Mar 1973, United Kingdom of Great Britain and Northern Ireland (UK). 4p.

An apparatus is described for purifying exhaust waste gases including a catalytic element comprising a substrate of metal carrying a surface layer compatible with and supporting a coating of catalytic material, a major proportion of the surface coating of catalytic material comprising an unagglomerated atomic dispersion. An example of such a substrate is an aluminum bearing ferritic steel which has been heat treated in air to form an essentially alumina surface layer.

3430 Internal combustion engine. Bachmann, W.V. US Patent 3,969,894. 20 Jul 1976. Filed date 3 Sep 1974. 24p.

An internal combustion engine includes an annular or ring-type cylinder and piston therein; exhaust ports from the cylinder lead to an afterburner reactor situated generally medially of the annular cylinder, the exhaust gases are further burned within the afterburner section; to further reduce pollutants during the afterburning process, additional air is pumped into the afterburner section by the ring piston due to its special configuration enabling it to accomplish, for example, triple functions such as: (a) to act as a power transmitting means, (b) to act as a pumping means to supply the engine's combustion chamber with scavenging air and/or an air-fuel mixture, and (c) to act as an air pumping means to supply desired quantities of ambient air into the afterburner section even in timed intervals with a constant predetermined pressure and predetermined quantities in order to thereby maximize the degree of control of the temperature generated in the afterburner and thereby more nearly fully oxidize the unburned fuel residues entering the afterburner. The ring piston is so constructed that it can be operatively connected to an output shaft as through the use of only a single crank, single connecting rod and wrist pin.

3431 Control system for exhaust gas recirculating valve. Caldwell, R.B. (to Ranco Inc.). US Patent 3,970,061. 20 Jul 1976. Filed date 7 Mar 1975. 12p.

An exhaust gas recirculation control system for an internal combustion engine is disclosed in which a pressure operated exhaust gas recirculation (EGR) valve governs the flow of engine exhaust gas into the engine intake. The EGR valve is supplied with operating pressure from the engine intake manifold via a pressure amplifier. The amplifier has a pressure input which tends to vary in relation to the flow rate of gas through the engine so that the EGR valve operating pressure varies as an amplified function of the amplifier input pressure signal. A control valve modifies the amplifier input signal as a function of intake manifold pressure to enable the EGR valve operation to be programmed as desired throughout the range of operation of the engine.

NITROGEN OXIDES

REFER ALSO TO CITATION(S) 3449

3432 (DOT-TSC-OST—76-22) **Engine performance test of the 1975 GM 140-CID. Interim report, August—September 1975.** Marshall, W.F.; Stamper, K.R. (Energy Research and Development Administration, Bartlesville, Okla. (USA). Bartlesville Energy Research Center). Jun 1976. 26p. Dep. NTIS $4.00.

An engine test of the 1975 GM 140 cubic-inch-displacement, 4-cylinder engine was performed to determine its steady-state fuel consumption and emissions (HC, CO, and NO/sub x/) maps. The data acquired are summarized.

3433 (NASA-TM-X—71547) **Experimental Clean Combustor Program: description and status.** Niedzwiecki, R.W.; Jones, R.E. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). 1974. 15p. NTIS.

From Society of Automotive Engineers Air Transport meeting; Dallas, Texas ;USA: (30 Apr 1974).

The Experimental Clean Combustor Program is described. The program objectives include the generation and demonstration of technology for development of advanced commercial CTOL aircraft engines with lower exhaust emissions than current aircraft and the demonstration of this technology in full scale engines in 1976. The program is being conducted in three phases: (1) the screening of low pollutant combustors; (2) refinement of the best combustors; (3) and engine demonstration of the best combustors. Pollution goals are emission index values of 20 and 4 for carbon monoxide and unburned hydrocarbons, respectively, at engine idle conditions and an oxide of nitrogen emission index level of 10 at engine takeoff conditions. Pollution reduction approaches which are being investigated include multiple burning zone combustors, investigations of improved fuel distribution, and preparation and staging of combustor airflow. Phase I of the program is approximately 50 percent completed, and preliminary test results indicate that all combustor designs, with sufficient additional effort, appear capable of achieving the idle pollutant goals. Reduction of NO/sub x/ by 50 percent are presently possible, though further reductions are at the expense of increased combustion inefficiencies at both low and high power conditions.

3434 Inter-Industry Emission Control Program: background. IIEC-1: a comprehensive summary. IIEC-2: goals and programs. McCabe, L.J.; Chase, C.B. pp vp of In Inter-Industry Emission Control Program-2 (IIEC-2) progress report No. 1. Warrendale, PA; Society of Automotive Engineers, Inc. (Jan 1975).

The Inter-Industry Emission Control Program (IIEC) was established in April 1967 by Ford Motor Company and Mobil Oil Corporation as a cooperative effort to accelerate development of a virtually emission-free, gasoline powered vehicle by combining expertise from both the petroleum and automotive industries. The emission goals and the technical accomplishments of the program are discussed, and lists of papers and patents are given. The continuation of the program, IIEC-2, emphasizes energy conservation in addition to very low exhaust emissions. (PMA)

3435 Effects of exhaust gas recirculation and residual gas on engine emssions and fuel economy. Kaneko, Y.; Kobayashi, H.; Komagome, R. pp vp of In Inter-Industry Emission Control Program-2 (IIEC-2) progress report No. 1. Warrendale, PA; Society of Automotive Engineers, Inc. (Jan 1975).

Three exhaust emissions, hydrocarbons, carbon monoxide and oxides of nitrogen, from the automotive spark-ignition engines are presently subject to regulatory control. Of these harmful pollutants, NO/sub x/ emissions are the hardest to control under current status of emission control technology. Accordingly, exhaust gas recirculation (EGR) has received continued efforts as one of promising NO/sub x/ control. The effects of EGR on the mechanism of NO/sub x/ reduction and engine fuel economy are reported on the basis of research made in the following areas: (1) NO/sub x/ formation in a combustion vessel; (2) studies on EGR effects in a single-cylinder engine; and (3) effects of EGR on NO/sub x/ and HC emissions and fuel economy.

3436 Trade-offs between engine emission control variables, fuel economy, and octane. Morgan, C.R.; Hetrick, S.S. pp vp of In Inter-Industry Emission Control Program-2 (IIEC-2) progress report No. 1. Warrendale, PA; Society of Automotive Engineers, Inc. (Jan 1975).

A single cylinder RDH (Removable Dome Head) spark ignition, gasoline engine operating at constant speed and load was used to study the effects of compression ratio, spark timing, exhaust gas recirculation (EGR) rate, and air/fuel (A/F) ratio on exhaust emissions, fuel economy, and octane requirements. Analyses showed that fuel consumption decreased with increasing compression ratio at any given NO/sub x/ emission level, so that minimum fuel consumption was obtained at the highest compression ratio studied when basic engine HC emissions were not a constraint. However, if both HC and NO/sub x/ emissions were constrained at constant low levels by optimal adjustments of EGR and spark timing, both the minimum fuel consumption and minimum octane number for trace knock were achieved at the lowest compression ratio studied. Furthermore, overall minimum fuel consumption at controlled HC and NO/sub x/ levels was obtained at the leanest A/F ratio (15.4) studied. These data indicate that the historically expected improvement in engine efficiency with increasing compression ratio may not always be achieved when HC and NO/sub x/ must be constrained due to emission requirements.

3437 Approach to the low emission engine with the consideration of fuel economy. Kuroda, H.; Nakajima, Y.; Hayshi, Y.; Sugihara, K. (Nissan Motor Co., Ltd., Yokosuka, Japan). pp vp of In Inter-Industry Emission Control Program-2 (IIEC-2) progress report No. 1. Warrendale, PA; Society of Automotive Engineers, Inc. (Jan 1975).

A number of approaches to the development of low emissions engines have been reported in the literature. Many of these approaches, however, have reduced emissions by retarding ignition timing. This increases exhaust gas temperatures for more complete HC oxidation in the exhaust system but results in a fuel economy penalty. Previous studies have indicated that NO/sub x/ can be effectively reduced with judicious use of exhaust gas recirculation (EGR). While this may result in increased HC emissions, under some conditions it also can result in improved fuel economy. Data are reported which demonstrate that the use of EGR is capable of reducing NO/sub x/ emissions and octane number requirements while improving fuel economy. Any resultant increase in HC emissions can be controlled with an efficient HC/CO oxidation catalyst.

3438 NO/sub x/ reduction catalyst development. Meguerian, G.H.; Rakowsky, F.W. pp vp of In Inter-Industry Emission Control Program-2 (IIECy2) progress report No. 1. Warrendale, PA; Society of Automotive Engineers, Inc. (Jan 1975).

Kinetics of ammonia formation were studied to delineate engine conditions for best net NO/sub x/ efficiency and to expand the choice of emission control systems. These studies were carried out in the laboratory with exhaust gases generated by a pulse flame generator and rhodium containing catalysts. Catalyst selectivity, NH_3/N_2, was found to vary linearly with the CO/O_2 ratio in the exhaust gas and with the reciprocal of the space velocity. The effects of temperature and input NO/sub x/ levels are more complex. Selectivity shows a maximum in the range of 750 to 1300°F and increases gradually as the NO/sub x/ level is decreased from 800 to 100 ppm. Based on these results, a mechanism is proposed for ammonia formation and a triple-catalyst system is suggested for increasing net NO/sub x/ efficiency.

3439 Reducing undesirable components of automotive exhaust gas. Romano, G.; Gorietti, B. (to Exxon Research and Engineering Co.). US Patent 3,964,258. 22 Jun 1976. Filed date 1 Aug 1973. 10p.

Undesirable pollutants in automotive exhaust gas are reduced using an emission control reactor to oxidize hydrocarbons and CO, and recirculation of some exhaust gas to the engine intake system to reduce NO/sub x/ content. The warm-up time of the reactor is reduced by delaying the ignition time until the minimum working temperature of the reactor is attained. The performance of the engine is improved by interrupting exhaust gas recycle when the engine is choked, or at idling or operating with open throttle.

3440 Nickel base NO/sub x/ reducing catalytic structure. Fedor, R.J.; Ogden, C.S. (to Gould Inc.). US Patent 3,969,480. 13 Jul 1976. Filed date 14 Mar 1974. 12p.

A system for reducing NO/sub x/ gases found in the exhaust stream of the internal combustion engine is described. A NO/sub x/ reducing catalyst assembly is connected to the exhaust manifold and includes a housing having a NO/sub x/ reducing catalytic structure of apertured thin metal foil. A durable, chromium containing corrosion resistant nickel base substrate has, on at least one surface, an effective amount of a NO/sub x/ reducing catalyst such as iron, nickel, cobalt, copper, manganese, or mixtures of these.

3441 Apparatus for controlling noxious exhaust gases from internal-combustion engine. Andoh, A. (to Clemix Co.). US Patent 3,970,052. 20 Jul 1976. Filed date 29 Oct 1974. 8p.

An apparatus is described for controlling and minimizing the production of the noxious exhaust gases from an automobile internal-combustion engine. Two passageways extend from an intake manifold provided with a throttle valve which is located between the two passageways. One of the two passageways leads to a control section provided with a diaphragm actuated in response to changes in the vacuum from the intake manifold for controlling the supply of water or like and air to the combustion chamber. The other passageway leads to a second control section provided with a diaphragm actuated in the same manner for controlling the supply of part of the exhaust gases and air to the combustion chamber for reburning them, thereby enabling the supply of water or like, air, and exhaust gases to be controlled according to the amount and type of the noxious exhaust gases.

CARBON MONOXIDE

REFER ALSO TO CITATION(S) 3432, 3433, 3434, 3439, 3441, 3449

3442 Exhaust gas emission control device for multi-cylinder engines. Sakurai, Y.; Okura, T. (to Honda Giken Kogyo Kabushiki Kaisha). US Patent 3,969,893. 20 Jul 1976. Priority date 15 Oct 1973, Japan. 4p.

Each cylinder of an internal combustion V-8 piston engine has a main combustion chamber and an auxiliary combustion chamber connected by a torch nozzle restriction. A main exhaust gas reaction chamber is positioned between the two banks of cylinders. Exhaust passages supply hot exhaust gases from the cylinders to exhaust gas tubes, each of which receives hot exhaust gases from two adjacent cylinders and projects through an insulated wall of the gas reaction chamber, to discharge into it toward an end wall thereof. A main exhaust pipe extends through a remote end wall at the opposite end of the reaction chamber. An exhaust gas induction member is positioned within the reaction chamber and receives the discharge from two of the exhaust tubes.

SULFUR DIOXIDE

3443 Gas turbine power plant with exhaust treatments for SO_2 removal. Williams, D.E.; Jubb, A. (to Rolls-Royce (1971) Ltd.). US Patent 3,962,864. 15 Jun 1976. Priority date 20 Sep 1973, United Kingdom of Great Britain and Northern Ireland (UK). 4p.

An energy system consists of a gas turbine engine having a power turbine which is arranged to drive a load. The exhaust from the power turbine passes to a further turbine which is arranged to drive a compressor, and the exhaust from the further turbine passes to atmosphere via the compressor and a combined cooler and scrubber in which water is heated and sulphur is removed from the hot exhaust gas. The combined cooler and scrubber consists of a bed of flints through which the hot exhaust gas flows and a condenser arranged to receive a supply of relatively cool water, the resulting hot water being stored in a hot water store. The bed of flints also receives a supply of water to which calcium carbonate and manganese sulphate has been added so that sulphur in the form of calcium sulphate is removed from the exhaust gas.

HYDROCARBONS

REFER ALSO TO CITATION(S) 3432, 3433, 3434, 3436, 3437, 3439, 3441, 3442, 3449

ALTERNATIVE FUELS

REFER ALSO TO CITATION(S) 2324, 2573, 3414

3444 (CONF-751238—, pp 104-116) **Emissions and other characteristics of a propane/butane fueled standard city bus.** Van Der Weide, J. (TNO, Delft, Netherlands). 1975.

From Symposium on low pollution power systems development; Rome, Italy (3 Dec 1975).

In Symposium on low pollution power systems development.

Results of tests are given for a standard city bus in which the diesel engine was changed into a spark-ignition engine fueled with liquefied petroleum gas. The objectives of the program are outlined, and the pertinent parts of an LPG engine are discussed. Data are given for fuel consumption, exhaust gases (NOx, HC, and CO), and noise. The program shows not only that gas-fueled buses have good emission values, but also that they compete successfully with diesel buses with respect to fuel economy and performance. (PMA)

3445 (DOT-TST—76-50) **Evaluation of methyl alcohol as a vehicle fuel extender. Final report.** Johnson, R.T.; Riley, R.K. (Missouri Univ., Rolla (USA). Dept. of Mechanical Engineering). Aug 1975. 167p. NTIS.

Methyl alcohol (methanol) can be made from coal and waste products with reasonable thermal efficiency. Strong interest in blending this liquid fuel with gasoline for automotive use has developed. A research program is described which characterized the behavior of methanol-gasoline blends in spark ignition engines, particularly those used in automobiles. The program included: characterizing octane ratings of methanol-gasoline blends, a single cylinder engine study of the effects of engine parameter variations on emissions and fuel economy of methanol-gasoline blends, and a simulated vehicle program to determine the behavior of the blends for the federal emissions test procedure. Results indicated that no substantial changes in emissions or fuel economy should be expected from operating blends of 10 percent or less in existing vehicles. Performance, vapor lock, phase separation, and corrosion problems are pointed out.

3446 (UCRL—52041) **Methanol engine: a transportation strategy for the post-petroleum era.** Vantine, H.C.; Chang, J.; O'Connell, L.G.; Rubin, B.; Westbrook, C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 25 Mar 1976. Contract W-7405-Eng-48. 34p. Dep. NTIS $4.00.

Several types of heat engines are considered as candidates for a methanol engine. Of those considered, the stratified-charge engine appears to be the most attractive. A stratified-charge engine optimized for methanol fuel is projected to result in an energy economy advantage of 44 to 71 percent (measured in miles per Btu) in comparison to an Otto engine operating on gasoline. This advantage arises from (1) the high octane rating of the fuel, which allows a high compression ratio to be used; (2) methanol's fuel-lean combustion characteristics, which allow efficient lean operation; and (3) the low flame temperature, which allows effective control of nitrogen oxide emissions. The design and optimization of a methanol engine are examined in terms of an experimental and calculational program. The relevant properties of methanol that should prove desirable in future engines are noted, and the

socioeconomic impact of methanol-fueled transportation is discussed.

3447 Establishment of ORI characteristics as a function of selected fuels and engine families. Niles, H.T.; McConnell, R.J.; Roberts, M.A.; Saillant, R. pp vp of In Inter-Industry Emission Control Program-2 (IIEC-2) progress report No. 1. Warrendale, PA; Society of Automotive Engineers, Inc. (Jan 1975).

Octane requirements of 55 cars, representing five Ford engine families, were determined every 2000 miles during a deposit accumulation schedule consisting of city, suburban, and highway operations. Five cars from each engine family were operated on certification durability fuel to establish the ORI (octane requirement increase) variation within and between families. Additional cars and fuels were used to investigate the effects of lead content, a detergent additive, and higher boiling fuel components on ORI. The data obtained show that among engine families there were characteristic differences in ORI and that the initial ORI build-up occurred more rapidly when the investigated detergent additive was used. The fuel with reduced tail-end volatility was found to increase ORI. ORI with leaded versus unleaded fuels was found to be greater with unleaded fuels but with wide variation between the engine families studied.

3448 Methanol—gasoline blends performance in laboratory tests and in vehicles. Crowley, A.W.; Kuebrich, J.P.; Roberts, M.A.; Koehl, W.J.; Wascher, W.L.; Wotring, W.T. pp vp of In Inter-Industry Emission Control Program-2 (IIEC-2) progress report No. 1. Warrendale, PA; Society of Automotive Engineers, Inc. (Jan 1975).

Blends of up to 20 percent methanol in gasoline were evaluated in both engine dynamometer and controlled vehicle tests, and in a 50,000 mile road test. Performance comparisons between methanol blends and base gasolines were made in vehicle driveability and vapor lock tendency, engine deposits and wear, fuel economy, exhaust emissions, compatibility with fuel system materials, and phase stability of the blends. Vapor lock tests in six 1974 cars strongly suggested that the vapor lock tendency of methanol blends is greater than would be predicted for gasolines having the same volatility characteristics. Cold start and warm-up driveability of two 1974 cars at 70°F depreciated as methanol concentration increased in base fuels of three volatility levels. These driveability data were found to correlate well, at a given methanol concentration, with fuel volatility characteristics described by means of a new fuel vaporization pressure technique. Engine deposits, rusting, wear, and crankcase oil performance were not significantly affected by methanol in gasoline when evaluated in four laboratory engine tests and in the four-car, 50,000 mile road test. Fuel consumption was found generally to increase with increasing methanol.

3449 Combustion and emission characteristics of methanol. Harrington, J.A.; Pilot, R.M. pp vp of In Inter-Industry Emission Control Program-2 (IIEC-2) progress report No. 1. Warrendale, PA; Society of Automotive Engineers, Inc. (Jan 1975).

A single cylinder engine was used to study the combustion and emission characteristics of methanol and indolene clear fuel. Measurements on ignition delays, combustion intervals, power, and exhaust emissions were made over a range of speeds, loads, and air-fuel mixture ratios. The results were used to determine the difference in relative power, efficiency, and emissions between the two fuels. Relative to indolene, methanol exhibits faster overall burning rates, (shorter ignition delay periods and combustion intervals). At the same engine air flows and equivalence ratios, methanol produces more power than indolene. Fuel consumption with methanol is higher but the energy consumption rate is lower. NO emissions with methanol are generally lower but, depending on equivalence ratio, CO and HC emissions are less than, equal to, or greater than those with indolene fuel.

3450 Fuel compositions containing glycerides for reducing the plugging of exhaust gas catalysts. Niebylski, L.M. (to Ethyl Corp.). US Patent 3,948,618. 5 Jun 1975. vp.

A gasoline composition for use with an internal combustion engine is described. A cyclopentadienyl manganese tricarbonyl compound, where the cyclopentadienyl group is a hydrocarbon group containing from 5 to about 17 carbon atoms is added as an antiknock agent. A glyceride is added to reduce the plugging of an exhaust gas catalyst.

3451 Method of operating an internal combustion engine with solvent refined coal as a fuel. Clark, W. US Patent 3,965,870. 29 Jun 1976. Filed date 3 Mar 1975. 4p.

A method of using solvent refined coal as a fuel for an internal combustion engine is disclosed. The fuel is provided in finely divided form and is aspirated into the cylinder on a suction stroke and heated by compression to a point at which the finely divided solid material liquefies into a fine spray. The liquid spray is then ignited by a glow plug at a temperature of at least 1000°F.

MATERIALS

REFER ALSO TO CITATION(S) 2512, 2513, 2514, 2533, 2556, 4123

3452 (COO—3153-141) Elastic and plastic deformation of solids. Final report, February 1, 1960—January 31, 1976. Ruoff, A.L. (Cornell Univ., Ithaca, N.Y. (USA). Dept. of Materials Science and Engineering). 15 Jul 1976. Contract E(11-1)-3153. 9p. Dep. NTIS $3.50.

This is a summary of the techniques used and the results obtained in the study of creep at high pressure, pressure dependence of yield stress and elastic constants, etc. 58 references. (DLC)

3453 (LBL—5125) Computer simulation of homogeneous nucleation and growth processes. Mahin, K.W. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). May 1976. Contract W-7405-ENG-48. 79p. Dep. NTIS $4.50.

Thesis.

The morphology of grain structures and the statistical distributions of their geometrical features in two and three dimensions are important factors which determine the effect a microstructure will have upon the physical and mechanical properties of a material. In order to fully characterize the microstructure, it is necessary to be able to correlate the mechanism of the transformation to the resultant morphology of the grain structure. The research reported deals with the development of a computer program capable of simulating a variety of transformation conditions and analyzing the resultant grain structures. Two ideal microstructure models were fully characterized by this process and the computer-generated results agree well with theoretical predictions. 28 figures.

METALS AND ALLOYS

REFER ALSO TO CITATION(S) 2388, 2532

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 2403, 3282

3454 (LA-UR—76-360) Fabrication of superconductors. Turner, W.C.; Lundberg, L.B.; Zeitlin, B.; deWinter, T.A.; McDonald, W.K. (Los Alamos Scientific Lab., N.Mex. (USA)). 1976. Contract W-7405-ENG-36. 15p. (CONF-760508—1). Dep. NTIS $3.50.

From 6. ICED meeting; Grenoble, France (11 May 1976).

The paper discusses the development of a process for making high performance, fine-filament superconducting wires, utilizing dual matrix stabilization and $Nb_{46}Ti$ superconducting filaments. Minimum filament size-achieved was 8 μm using OFHC copper and $Cu_{30}Ni$ matrix materials. Ductility of the NbTi starting material was found to exert a major influence on the properties of the finished wire, and specifications for acceptable NbTi were developed. When specific impurity levels are exceeded, micron size precipitates and large inclusions are found. A rigorous stacking and extrusion procedure was developed. Very high density billets for extrusion were obtained by such techniques as co-drawing the stacking elements, contouring shells on a gear shaper, and hydrostatic compaction. Extrusion parameters discussed are reduction ratios, temperatures, and working speeds. (auth)

3455 (LBL—5121) Superconductors by powder metallurgy techniques. Pickus, M.R.; Wang, J.L.F. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). May 1976. Contract W-7405-ENG-48. 16p. (CONF-760658—2). Dep. NTIS $3.50.

From Symposium on evaluating and controlling the corrosive effects of chlorides on reinforced steel in concrete; Chicago, Illinois, United States of America (USA) (30 Jun 1976).

Fabrication methods for Nb_3Sn type compounds are described. Information is included on the Bell Telephone process, the General Electric tape process, superconductor stability, the bronze process, powder metallurgy multifilamentary tapes and wires, and current assessment of powder metallurgy superconducting wire. (JRD)

3456 (SAND—76-5292) Characterization of the thermosonic wire bonding technique. Johnson, D.R.; Chavez, E.L. (Sandia

Labs., Albuquerque, N.Mex. (USA)). 1976. Contract AT(29-1)-789. 16p. (CONF-761004—2). Dep. NTIS $3.70.

From International microelectronics symposium; Vancouver, B. C., Canada (11 Oct 1976).

A study was conducted to evaluate the contribution of the thermosonic bonding technique to solid phase bonds on both thin film metallized substrates and thick film metallized component terminations. The experimental materials and procedures, the bonding parameters, and the test results are presented. Results show that the thermosonic bonding process is capable of producing fine wire gold bonds to a variety of thin and thick film metallized surfaces. These bonds exhibited excellent metal to metal adherence and high tensile strengths. On the basis of the results it is recommended that the thermosonic wire bonding technique be incorporated as an in-house capability for Sandia's hybrid microcircuit interconnection applications. Further, the advantages of this process suggest that the thermosonic technique should be considered for production line utilization during component manufacturing. Additional investigation of this technique, for both development and production applications, should be pursued, especially with regard to comparison with other techniques such as pulsed thermocompression bonding.

3457 (SAND—76-5721) **Resistance increases in gold aluminum interconnects with time and temperature.** Bushmire, D.W. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1976. Contract AT(29-1)-789. 17p. (CONF-761004—3). Dep. NTIS $3.50.

From International microelectronics symposium; Vancouver, B. C., Canada (11 Oct 1976).

Increases in the resistance of gold-aluminum interconnects with time and temperature were investigated. Aluminum wire was ultrasonically bonded to Cr-Au and TiPd-Au thin film metallization on ceramic substrates. The interconnects were exposed to temperatures from 150 to 300°C and times up to 400 hours. The resistance of the interconnects was measured periodically during the exposure to elevated temperatures. There were significant increases of resistance on both types of metallization. Some measurements indicated electrically open interconnects, but the mechanical strength remained high. If systems containing gold-aluminum interconnects are anticipated to be processed or used at or above 150°C, serious consideration should be given to the effects of increased resistance on circuit performance.

3458 (WAPD-TM—1063) **Brazing fixture materials for fabrication of AM-350 fuel rod support grids (LWBR development program).** Towner, R.J. (Bettis Atomic Power Lab., West Mifflin, Pa. (USA)). Aug 1976. Contract E(36-1)-Gen-14. 48p. Dep. NTIS $4.00.

Results are presented of an investigation of the thermal expansion and contraction, anisotropy, and dimensional stability characteristics of candidate brazing fixture materials for LWBR fuel rod support grid structures. These characteristics are assessed in regard to their compatibility and usefulness with AM-350 grid material during two different brazing/fabrication processes, M and A, both of which involve 2070 to 2080°F brazing in vacuum. Fixture materials evaluated for Process M are AM-355, low-carbon, low-nitrogen AM-350, and M2 tool steel. NiCrFe Alloy 600 is evaluated for Process A. Subsequent experience with development and production brazing fixtures for full-size grids is summarized.

3459 (Y/DA—6662) **Metallurgical processing of the uranium-0.75 titanium alloy.** Jessen, N.C. (Oak Ridge Y-12 Plant, Tenn. (USA)). 12 May 1976. Contract W-7405-Eng-26. 23p. (CONF-760540—13). Dep. NTIS $3.50.

From Conference on high density alloy penetrator materials; Charlottesville, Virginia, United States of America (USA) (24 May 1976).

Although the addition of titanium is an effective means of strengthening uranium, careful control of casting, homogenization, and heat treatment are necessary to optimize mechanical properties. Quenching of the alloy provides increased strength and elongation; however, subsequent low temperature aging will increase the strength even higher at the sacrifice of ductility. The properties of the alloy are quench rate sensitive and quenching produces high residual stresses in the alloy. The residual stresses can be reduced by mechanical deformation with only slight degradation of the mechanical properties. 15 figures.

3460 (Y/DA—6663) **Melting and casting of high quality uranium and uranium alloy ingots.** Banker, J.G. (Oak Ridge Y-12 Plant, Tenn. (USA)). 12 May 1976. Contract W-7405-eng-26. 19p. (CONF-760540—11). Dep. NTIS $3.50.

From Conference on high density alloy penetrator materials; Charlottesville, Virginia, United States of America (USA) (24 May 1976).

Uranium alloys containing titanium, niobium, zirconium, and molybdenum are produced in batches weighing up to 800 kg and cast into ingots or final shapes. The processing techniques utilized depend upon the alloy composition and upon quality limitations. Unalloyed uranium and alloys containing titanium and molybdenum are normally produced by vacuum induction melting; however, these alloys can also be produced by vacuum arc melting if high purity is necessary. The U—2 Nb alloy is generally produced by induction melting unalloyed uranium with U—6 Nb alloy scrap. Large ingots of U—6 Nb and U—7.5 Nb—2.5 Zr are generally produced by vacuum arc melting. When some refining of the charge material is required, such as in the consolidation of U—7.5 Nb—2.5 Zr machine turnings, electroslag melting is often desirable. Details of the various alloys and their respective characteristics and processing procedures are discussed under each process category. 7 tables, 10 figures. (DLC)

3461 (Y/DA—6666) **Fabrication development of tungsten alloy penetrators.** Northcutt, W.G. Jr. (Oak Ridge Y-12 Plant, Tenn. (USA)). 10 May 1976. Contract W-7405-eng-26. 13p. (CONF-760540—9). Dep. NTIS $3.50.

From Conference on high density alloy penetrator materials; Charlottesville, Virginia, United States of America (USA) (24 May 1976).

A summary is presented of the fabrication development of W—3.5 Ni—1.5 Fe and W—7 Ni—3 Fe alloys. Liquid-phase sintering of isostatically cold-pressed powder compacts in hydrogen was employed together with subsequent heat treatments and swaging. Tensile properties, hardness, density, and microstructure were correlated with cold work. (DLC)

3462 (ANL-Trans—1071) **Process for the treatment of niobium surfaces for alternating current applications.** Martens, H. (Siemens A.G., Berlin (Germany, F.R.)). 10 Aug 1972. Translation of German Patent No. 2,239,425. 16p. Dep. NTIS $3.50.

Object of the invention is to produce Nb with good surface characteristics for application as an ac superconductor without requiring outgassing in uhv. The invention is based on the discovery that a Nb surface coated with Nb_2O_5 by anodization in an electrolyte which is free from HE and does not attack Nb_2O_5, continues to exhibit excellent superconducting properties even after chemical separation of the Nb_2O_5 coating. This coating removal is preferentially accomplished using 40 to 50 percent HF and ultrasonics. In this way, cavity resonators and conductors have been produced. (DLC)

3463 **Morphology relations during surface-transport controlled sintering.** German, R.M.; Munir, Z.A. (Sandia Labs., Livermore, CA). *Metall. Trans., B;* **6B**: No. 1, 289-294(Mar 1975).

Precise geometrical relationships have been calculated for the surface-transport controlled sintering of sphere to sphere configurations. A minimum surface area neck configuration is assumed and interparticle coordination is considered. The calculated results for surface-transport controlled sintering show a small particle size reduction during neck growth. In contrast, the concurrent surface area reduction is shown to be significantly large. Based on the morphology results of these calculations, an empirical expression relating neck size and coordination to surface area has been derived. Thus, surface area is proposed to be an alternative measure to neck size during surface-transport controlled sintering studies. Previous experimental results are generally in good agreement with the calculations provided by the proposed model.

3464 **Low-pressure sputtering of high-T/sub c/Nb_3Ge.** Kammerdiner, L.; Wu, C.T.; Luo, H.L. (Univ. of California, San Diego, La Jolla). *J. Low Temp. Phys.;* **24**: No. 1/2, 111-115(Jul 1976).

A modified technique for the sputtering of high-T/sub c/Nb_3Ge using low Ar pressure is reported. The experimental arrangement involved only conventional equipment and ordinary vacuum conditions. Nb_3Si with the A-15 structure was also prepared in a similar manner.

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 2828, 3281, 3528

3465 **Precipitation of epsilon—carbide in lower bainite.** Lai, G.Y. (Univ. of California, Berkeley). *Metall. Trans., A;* **6**: 1469-1471(Jul 1975).

AISI 4340 and 300 M steels were investigated. The orientation relation of (100)/sub α/ //(1120)/sub e/ carbide was observed in both lower bainite and tempered lath martensite, supporting the view that in lower bainite, carbides precipitate directly from supersaturated ferrite. (DLC)

3466 **Crystal data for $NpGa_3$.** Russell, A.M.; Roof, R.B.; Elliott, R.O. (Los Alamos Scientific Lab., N.Mex. (USA)); Giessen, B.C. (Northeastern Univ., Boston, Mass. (USA)). *J. Appl. Crystallogr.;* **9**: No. 3, 244(1 Jun 1976).

The structure of $NpGa_3$ is ordered $AuCu_3$-type cubic, space group Pm3m, with a_o=4.25451+-0.00008 A. Powder data are given.

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 2390, 2391, 2392, 2393, 2394, 2395, 2396, 2397, 2398, 2399, 2400, 2401, 2402, 2404, 2405, 2406, 2407, 2744, 2858, 3028, 3459, 3503

3467 (AGARD-CP—185) **Alloy design for fatigue and fracture resistance. Specialists meeting held at Brussels, Belgium, 13—19 April 1975.** (Advisory Group for Aerospace Research and Development, 92 - Neuilly-sur-Seine (France)). 1976. 170p. (CONF-750407—). NTIS.

From 40. meeting of the structures and materials panel; Brussels, Belgium (14 Apr 1975).

The meeting was concerned with three major systems of aerospace structural alloys, i.e., aluminum alloys, titanium alloys, and high strength steels. The greatest progress has been made with aluminum alloys. The relationship between microstructure and engineering properties appears to be well understood, and this knowledge has been put effectively into practice to produce better alloys. It must be noted, however, that this endeavor has been more successful with respect to fracture toughness than to fatigue resistance, although powder metallurgy may provide a breakthrough in the latter aspect. For titanium alloys there are ample indications of effects of microstructure on mechanical properties, but there seems to be a lack of the systematic understanding which would be required to make necessary improvements. In all fairness it has to be admitted that the titanium alloy system is the most complex of the three discussed. Most titanium alloys are multiphase and they do not contain the inclusions that through proper control of content, size, and spacing readily provide a means to achieve better properties as in the case of aluminum and steel. The situation for high strength steel is somewhat dualistic. For example, control of inclusion morphology has been found to provide increased fatigue strength and fracture toughness. But the high strength steels that today are applied in landing gear and in other items where a high strength has to be provided in a small space have still such low tolerance to flaws, that such members are almost invariabiy designed on a safe life basis. The improvements in crack propagation resistance and residual strength have to be very large indeed before the designers will feel justified in adopting a fail safe philosophy. The exploitation of deformation induced transformation of retained austenite, for example, may be a technical possibility but has to be approached with great caution still.

3468 (ANL—76-58) **Unified and mechanistic approach to creep-fatigue damage.** Majumdar, S.; Maiya, P.S. (Argonne National Lab., Ill. (USA)). Jan 1976. Contract W-31-109-eng-38. 32p. AT.

A new creep-fatigue damage-rate equation is proposed that takes into account both plastic strain and strain rate. The coefficients and exponents in the damage-rate equation are interpreted by means of the various damage mechanisms of the material. The damage-rate equation has been integrated to analyze various phenomena such as the effects of plastic strain rate on monotonic tensile or creep rupture time, rising mean strain on the low-cycle fatigue behavior at elevated temperature, tensile and compressive hold times on the low-cycle fatigue life at elevated temperature, and cyclic creep. The proposed approach has been successfully applied to elevated-temperature data generated for Type 304 austenitic stainless steel under various monotonic and cyclic-loading conditions. The approach does not separate the inelastic strain into plastic (time independent) and creep (time dependent) components. It is recognized that the effect of plastic strain rate on the damage process is of major importance and the fact that the damage encountered in any deformation path depends not only on the plastic strain accumulated, but also on the rate at which the plastic strain is accumulated is accounted for. Thus, the damage due to several loading histories of interest can be computed in a simple and unified manner.

3469 (BDX—613-1409(Rev.)) **Thermally conductive syntactic foam.** McIlroy, H.M. (Bendix Corp., Kansas City, Mo. (USA)). Aug 1976. Contract E(29-1)-613. 35p. Dep. NTIS $4.00.

A low density, high thermal conductivity syntactic foam has been formulated from carbon and graphite microballoons with a polyimide binder resin and graphite fibers. The flexural properties of strength and deflection were increased by using the graphite fibers and the failure mode was increased from a brittle to an elastic mode.

3470 (COO—2354-2) **Cluster carburizing. Progress report, June 1, 1974—May 31, 1975.** Morral, J.E. (Connecticut Univ., Storrs (USA)). 1976. Contract AT(11-1)-2354. 14p. Dep. NTIS $3.50.

Tantalum alloys containing 27 at percent Hf were vacuum carburized at 1900°K in flowing methane. The rate of carbon absorption, for methane pressure between 13 and 133 Pa, was determined from the rate of carbide formation. The rates determined by this technique were similar to those observed for the absorption of carbon in pure Ta. In a preliminary test of the cluster carburizing concept, a solutionized and quenched sample was simultaneously aged hardened and carburized at 1273°K for one hour. A hardened zone, 20 μm deep, formed adjacent to the surface. The zone had a hardness of 800 KHN compared with 500 KHN for the age hardened and 300 for the solutionized alloy. These results can be applied to predicting suitable cluster carburizing conditions.

3471 (COO—3153-127) **Effect of hydrostatic pressure on the stress strain behavior of potassium and lead at liquid nitrogen temperature.** Chua, J.O. (Cornell Univ., Ithaca, N.Y. (USA). Materials Science Center). Jun 1975. Contract E(11-1)-3153. 151p. Dep. NTIS $6.75.

Thesis.

The hypothesis that at low homologous temperature, the pressure effect on the yielding of metals is closely related to the effect of pressure on the elastic constants was tested. An apparatus in which tension tests can be made at liquid nitrogen temperature and high hydrostatic pressure was designed and constructed. Tension tests for potassium and lead were carried out at liquid nitrogen temperature and as a function of pressure up to 5.15 kbars. The results show that the effect of hydrostatic pressure was to raise the stress strain curves of both potassium and lead at liquid nitrogen temperature.

3472 (COO—3459-10) **Effects of hydrogen and temperature on fatigue of vanadium. Annual report.** Stoloff, N. (Rensselaer Polytechnic Inst., Troy, N.Y. (USA)). 15 Jan 1976. Contract AT(11-1)-3459. 22p. Dep. NTIS $3.50.

Fatigue behavior of vanadium unalloyed and alloyed with 132, 400, and 1000 ppM hydrogen were determined in both stress control and strain control at room temperature. In addition, stress-control tests were conducted on vanadium and the 1000 ppM H_2 alloy at 400 and 600°C in air. S-N data from stress-controlled tests revealed a pronounced improvement in fatigue life for hydrided vanadium, but little or no effect for 132 ppM H_2 in solution. Similarly, strain-control tests showed no effects of hydrogen in solution on either cyclic hardening or fatigue life, in marked contrast to previous results for vanadium containing hydride particles. High-cycle fatigue tests on vanadium and the V-1000 ppM H_2 alloy at room temperature as a function of test frequency showed a marked decrease in life for decreasing frequency for the alloy, but little effect for vanadium. These results furnish an explanation for previously reported anomalies between fatigue lives obtained in stress and strain control tests. Additional tests run as a function of oxygen content in low hydrogen alloys show that varying oxygen levels cannot account for observed changes in properties with hydrogen. Transmission microscopy was utilized to demonstrate differences in fatigue substructures obtained with hydrogen content. 6 figures.

3473 (COO—3476-12) **Applications of microdynamics and lattice mechanics to problems in plastic flow and fracture. Progress report, January 1, 1975—December 31, 1975.** Bilello, J.C.; Liu, J.M. (State Univ. of New York, Stony Brook (USA). Dept. of Materials Science). 1976. Contract AT(11-1)-3476. 21p. Dep. NTIS $3.50.

The dynamical interaction of a propagating crack with twinning and slip in W and Mo crystals was measured. From static experiments, the effective radius of curvature at a crack tip and the local stress concentrations were determined, showing that the actual surface energy of Mo and W crystals is 50 percent smaller than previously considered. Work has also progressed on studies of interstitial impurity interactions where observations have been made on dislocation mobility, pinning energy, and pinning point separation by correlating etch-pit measurements with microstrain observations. Results show that oxygen has a binding energy approximately 0.05 eV to edge-dislocations in Mo and that lowering the oxygen concentration to a few ppM increases the dislocation velocity by approximately one order of magnitude when compared to less pure single pass EBZR crystals with 150 ppM total interstitials. 8 figures.

3474 (LBL—4574) **Effect of tempering on the strength and toughness of a series of Fe—Cr—Si—C alloys.** Wylie, E.A. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jan 1976. Contract W-7405-ENG-48. 45p. Dep. NTIS $4.00.

Thesis.

The mechanical properties of a series of high strength Fe—Cr—C alloys with silicon additions of 1.5, 2.0 and 3.0 percent

were determined for the as-quenched and the tempered conditions. Small additions of silicon to steel have been used in the past because it is a very potent solid solution strengthener of iron and it also increases the hardenability of steel. However, the unique ability of silicon to delay the decomposition of retained austenite and to prevent the precipitation of the embrittling cementite phase at intermediate tempering temperatures may be its most important function as an alloying element. By allowing tempering to take place at higher temperatures without the nucleation and growth of the non-coherent iron carbide, increased internal stress relief can be accomplished. The resulting combination of strength and toughness (210 ksi yield strength and 100 ksi√in. fracture toughness) of these alloys, which was developed using a conventional quench and temper heat treatment, allows them to be classified near the high strength-high toughness band of the 18 Ni maraging steels. The fracture toughness of these alloys is higher than that of the current high strength, low alloy steels at the same strength levels. Results of the investigation show that iron alloys with superior properties can be designed from the metallurgical understanding of simple alloy systems. Supplemental adjustments to composition and heat treatment can then be made to optimize the desired mechanical properties.

3475 (NRL-Report—8004) **Effect of section size on the fatigue crack growth rate of A516-60 pressure vessel steel.** Sullivan, A.M.; Crooker, T.W. (Naval Research Lab., Washington, D.C. (USA)). 4 Aug 1976. 17p. Naval Research Lab., Washington, DC.

Results of studies of the fatigue crack growth rate of A516-60 pressure-vessel steel indicate no section-size effect in stress-relieved specimens ranging in thickness from 6.35 to 50.8 mm. A regression curve equation for all thicknesses, relating cyclic crack growth rate (da/dN) to crack-tip stress-intensity factor range (ΔK) is obtained. The significance of these results is discussed in the light of current engineering practice and of previous studies of size effects in fatigue crack propagation.

3476 (ORNL—5136) **High-temperature structural design program semiannual progress report for period ending December 31, 1975.** Corum, J.M.; Pugh, C.E. (Oak Ridge National Lab., Tenn. (USA)). Jul 1976. Contract W-7405-Eng-26. 136p. AT.

Research directed to development of verified high temperature structural design methods and criteria applicable to LMFBR and other reactor system components is reported. Information is included on uniaxial behavior tests, constitutive equation development, computer-based structural analysis methods, inelastic structural tests, failure criteria studies, design criteria, design analysis methods for structural alloys other than types 304 and 316 stainless steel, and design methods for weldments. (JRD)

3477 (ORNL—5174) **Effect of long-term aging at 815°C on the tensile properties and microstructural stability of four cobalt- and nickel-base superalloys.** Hammond, J.P. (Oak Ridge National Lab., Tenn. (USA)). Aug 1976. Contract W-7405-eng-26. 31p. Dep. NTIS $4.00.

Two heats of Haynes alloy 25 and one heat each of Haynes alloy 188, Hastelloy N, and Inconel 625 were tensile tested after aging for 11,000 h at 816°C. Yield strength, ultimate tensile strength, and elongation were determined 24, 316, 760, and 982°C and compared with typical properties for these materials in the solution annealed condition. Toughness values were determined for these materials from their engineering stress-strain curves. The long-term aging treatment degraded ductility and toughness at room temperature but, contrary to behavior expected for overaging, enhanced them over those for the solution annealed condition in tests at 760°C. The tensile properties of the aged superalloys were correlated with mode of fracture and the amounts, identity, and morphology of the precipitates. Aging substantially depleted the hardener tungsten from the matrix in the cobalt-base alloys.

3478 (ORNL/TM—5553) **Use of a modified beam in obtaining creep data in uniaxial tension and compression.** Robinson, D.N.; Battiste, R.L.; Richardson, M. (Oak Ridge National Lab., Tenn. (USA)). Aug 1976. Contract W-7405-eng-26. 20p. AT.

A method of testing is presented which makes use of a special "slotted" beam to compare the tensile and compressive creep response of a metal at high temperature. The technique avoids most of the difficult alignment problems associated with conventional uniaxial testing in compression. Application of the method is made to 2 1/4 Cr—1 Mo steel, a primary reactor system metal. It is concluded that the elastic-creep behavior of this alloy is effectively the same in compression as in tension. Moreover, the "slotted" beam is judged a practicable tool for obtaining reliable creep data in tension and compression.

3479 (UCID—17247) **Holographic determination of the yield strength of a welded stainless steel pressure vessel.** Meyer, M.D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 14 Jul 1976. Contract W-7405-Eng-48. 15p. Dep. NTIS $3.50.

The strength and toughness of a high energy rate formed (HERF'ed) stainless steel, as influenced by the heat input from a variety of welds, are being measured. Using holographic interferometry, a welded spherical pressure vessel constructed from HERF'ed stainless steel with a composition of 21 percent Cr, 6 percent Ni, 9 percent Mn, 0.23 percent N, balance Fe was examined. Holographic examination of the weld vicinity shows that plastic deformations in the heat affected zones reach a maximum at a distance of 5 mm on either side of the weld, and tails off for another 20 mm to zero strain. The yield and ultimate strengths of the heat affected zones, based on the thin wall relation and using the wall thickness just above the weld, is nearly that of the parent material. However, the mode of deformation indicates that if the heat affected zones were either of higher strength or narrower, the pressure vessel would be stronger. Several more vessels are being electron beam welded using different weld parameters, and these will be examined to determine how the strength of the vessel is affected.

3480 (Y/DA—6664) **Low-addition in uranium alloy development in the Oak Ridge Y-12 Plant.** Koger, J.W.; Hemperly, V.C. (Oak Ridge Y-12 Plant, Tenn. (USA)). 10 May 1976. Contract W-7405-eng-26. 13p. (CONF-760540—12). Dep. NTIS $3.50.

From Conference on high density alloy penetrator materials; Charlottesville, Virginia, United States of America (USA) (24 May 1976).

The U—2.25 Nb, U—2 Mo, and U—0.75 Ti alloys are prepared in the Oak Ridge Y-12 Plant by vacuum-induction melting, processed with conventional metallurgical techniques, and age hardened after solution treating and water quenching. High strengths with good ductility are readily obtained. Of the three, the U—2 Mo alloy shows the lowest ductility and the U—0.75 Ti alloy shows the highest ductility, when all are hardened to comparable strength levels. 9 figures.

3481 (Y/DA—6667) **Variables affecting the properties of tungsten—nickel—iron alloys.** Northcutt, W.G.; Johnson, D.H.; Ferguson, J.E.; Snyder, W.B. (Oak Ridge Y-12 Plant, Tenn. (USA)). 12 May 1976. Contract W-7405-eng-26. 28p. (CONF-760540—14). Dep. NTIS $4.00.

From Conference on high density alloy penetrator materials; Charlottesville, Virginia, United States of America (USA) (24 May 1976).

Variables affecting the properties of W-3.5 Ni-1.5 Fe alloys are reviewed. Information is included on the effects of rolling and strain aging, prestraining, and strengthening by additional alloying. (JRD)

3482 (DP-TR—5) **Relation between strength and structure in high temperatue deformation.** Sellars, C.M.; Tegart, W.J.McG. Translated by M.S. Feldman from *Mem. Sci. Rev. Metall.*; **63**: No. 9, 731-746(1966). 29p. Dep. NTIS $4.00.

A review is given on the limits of available expressions for correlation of strength and high temperature. A new relation is proposed between rate of deformation (epsilon), stress (sigma), and temperature (T) in the formula: epsilon = A(/sub sin h/ ασigma)/sup n'/ exp[-Q/RT]. A, α, n' are constants independent of temperature and Q is the activation energy. Data on creep and torsion at high temperature, for a number of metals and alloys are related satisfactorily by this formula. The activation energies obtained are related to structural changes during deformation at high temperature. The results of hot torsion for several aluminum base alloys and a series of copper-nickel alloys are discussed. The alloying elements in solid solution have a marked effect on strength and ductility under the conditions of hot working, although the structural changes remain similar to those of the pure metals.

3483 (EURFNR—1285) **Comparative stress-rupture and creep tests on three titanium-stabilized 15/15 CrNi steels with different W—Mn—Mo and boron contents.** Schirra, M.; Seith, B.; Solano, R.R.; de las Rivas, M. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Material- und Festkoerperforschung). Jul 1975. Translation of KFK—2180. 53p. Dep. NTIS $4.50.

Results of comparative stress-rupture tests on three titanium-stabilized Cr—Ni steels are presented. The steels are potential cladding materials for fast reactor fuel elements and have been investigated for years in a variety of test programs to determine their behavior under reactor operating conditions. These investigations have shown that titanium-stabilized 15/15 CrNi steel, standard designation X10NiCrMoTiB 1515 (1.4970), best meets the requirements and has the greater potential; for this reason it is being proposed as cladding for the first core of the German SNR 300 fast breeder reactor now under construction.

3484 **Deformation and rupture of the transiently heated Zircaloy tube.** Clay, B.D. (Central Electricity Generating Board Berkeley, Eng.); Healey, T.; Redding, G.B. *Trans. Am. Nucl. Soc.*; **23**: 138(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3485 Effect of strain rate on the tensile properties of a bainitic 2 1/4 Cr—1 Mo steel. Klueh, R.L.; Oakes, R.E. Jr. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.;* **23**: 139(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 2389, 2537, 3282, 3285, 3469, 3555

3486 (ANL-CEN-RSD—76-1) **Properties for LMFBR safety analysis.** (Argonne National Lab., Ill. (USA)). Mar 1976. Contract W-31-109-Eng-38. 116p. Dep. NTIS $5.50.

This handbook brings together the most current data on thermodynamic, transport, and mechanical properties of reactor materials (fuel, coolant, structural material) for reactor safety analysis. NSMH (Nuclear Systems Materials Handbook) property code numbers and formats were used. The materials covered are UO_2, (U, Pu)O_2, Na, and Types 304 and 316 stainless steels. (DLC)

3487 (CONF-760513—1) **Characterization of high-T/sub c/ Nb—Ge thin films by ion scattering, ion-induced x-rays, and ion resonance techniques.** Miller, J.W.; Appleton, E.R.; Murphree, Q.C.; Gavaler, J.R. (Oak Ridge National Lab., Tenn. (USA); Westinghouse Research Labs., Pittsburgh, Pa. (USA)). 1976. 17p. Dep. NTIS $3.50.

From 22. international instrumentation of the Instrument Society of America; San Diego, California, United States of America (USA) (25 May 1976).

Thin films of high-T/sub c/ (21-22°K) Nb—Ge were analyzed using three ion bombardment techniques. The depth dependence of stoichiometry in these superconducting thin films is determined by the deconvolution of a series of Rutherford backscattering spectra using 2.0-3.2 MeV ^{4}He ions at several incidence and scattering angles. Confirmation of these results is provided by studying the yields of Nb and Ge characteristic X-rays as a function of the angle of beam incidence. The depth dependence of oxygen, or oxides of Nb and Ge, is of particular interest, but more difficult to determine. A very sharp ion scattering resonance ^{16}O (α,α) at 3.045 MeV was utilized to enhance the backscattered yield and depth sensitivity of oxygen determination. The combined use of these three techniques now provides a nearly complete and nondestructive means for the characterization of such films. (auth)

3488 (COO—3151-63) **Experimental phonon physics. Progress report, April 1, 1975—March 31, 1976.** Pohl, R.O.; Sievers, A.J. (Cornell Univ., Ithaca, N.Y. (USA). Lab. of Atomic and Solid State Physics). 1976. Contract E(11-1)-3151. 14p. Dep. NTIS $3.50.

Research on the following topics is summarized: thermal properties of glasses, disordered crystals, and compacted and sintered microcrystalline solids; effect of neutron irradiation on the thermal properties of vitreous SiO_2; amorphous phase of solid oxygen; lattice defect modes; infrared properties of glass, semimetals, and semiconductors; and far infrared absorption by small metal particles. Work receiving MSC support, invited talks given during 1975, and papers published during 1975 are also included. (BJG)

3489 (ORNL—5137, pp 156-168) **Molecular and materials research.** May 1976.

In Physics Division annual progress report for period ending December 31, 1975.

A chamber in which photoelectron spectroscopy can be carried out under ultrahigh-vacuum conditions was constructed; it will be used in the study of the electronic structure of molecules adsorbed onto surfaces. Two photon sources were constructed, an x-ray source with changeable anodes and a He I discharge lamp with a device for polarization. Photoelectron spectra were taken on ethylene and propane. Electron-charge-density distributions surrounding impurity atoms in Au, valence states of BaFeO/sub x/, and the electric quadruple interaction at ^{161}Dy in Gd_2O_3 were studied. Other topics investigated were the rf surface resistance of Pb near the critical temperature, infrared spectra of SO_3F^- and $SO_3(OH)^-$ in solid solution, and He implantation in potential first-wall CTR materials. The high-resolution microscopy program is briefly reviewed. 6 figures, 3 tables. (RWR)

3490 (ORNL-tr—4209) **Hydrogen diffusion in Pd and Pd/Ag hydrides of high hydrogen concentration.** Wicke, E.; Bohmholdt, G. Translated by R.G. Mansfield from *Z. Phys. Chem. (Frankfurt);* **42**: 115-118(1964). 4p. Dep. NTIS $3.50.

Equations representing the diffusion of H in Pd_2H and Pd_2H/Agh are presented. Tubes composed of Pd and Pd/Ag were used to measure H diffusion coefficients. Diffusion coefficient data are presented in plots. (JRD)

3491 Effect of doping on the resonance Raman scattering in InSb near the E_1 transition. Yu, P.Y. (IBM Research Center, Yorktown Heights, NY); Shen, Y.R. pp 453-457 of In Physics of semiconductors. Pilkuhn, M.H. (ed.). Stuttgart; B. G. Teubner (1974).

From 12. international conference on the physics of semiconductors; Stuttgart, F.R. Germany (15 Jul 1974).

See CONF-740722—.

Resonant Raman Scattering (RRS) of highly doped InSb at the E_1 transition has been measured. Increase in impurity concentration broadens and shifts the RRS peaks toward lower energies and changes the peak height of the surface-field-induced (SFI) LO phonon and 2LO phonon curves. Our results suggest an alternate explanation for the donor concentration dependence of I(LO)/I(TO) (I(LO) and I(TO) are Raman intensities of the SFI LO phonon and TO phonon respectively) observed by Pinczuk and Burstein. (auth)

3492 Magneto-electroreflectance in Ge, InSb, and GaAs. Ranvaud, R. (Max Planck Institut fuer Festkoerperforschung, Grenoble, France); Alibert, C.; Joullie, A.M.; Cordona, M. pp 546-540 of In Physics of semiconductors. Pilkuhn, M.H. (ed.). Stuttgart; B. G. Teubner (1974).

From 12. international conference on the physics of semiconductors; Stuttgart, F.R. Germany (15 Jul 1974).

See CONF-740722—.

Direct interband magneto-optical transitions have been observed by means of high resolution electroreflectance using magnetic fields up to 147.7 kG in the Faraday configuration. Low temperature results are reported for the E_0 transition of Ge and for the E_1 and $E_1 + \Delta_1$ edge of InSb. (auth)

3493 Spin-flip Raman scattering. Brueck, S.R.J. (Massachusetts Inst. of Tech., Lexington). pp 780-787 of In Physics of semiconductors. Pilkuhn, M.H. (ed.). Stuttgart; B. G. Teubner (1974).

From 12. international conference on the physics of semiconductors; Stuttgart, F.R. Germany (15 Jul 1974).

See CONF-740722—.

The polarization selection rules, resonance enhancement and spontaneous linewidth of spin-flip Raman scattering in InSb in the 5 μm near resonance regime are reviewed. The suitability of the InSb spin-flip Raman laser for spectroscopic applications is discussed. (auth)

3494 Study of Mott transition and observation of strong microwave induced spin-flip Raman light scattering in n-type CdS. Romestain, R. (Bell Labs., Murray Hill, NJ); Geschwind, S.; Devlin, G.E.; Wolff, P. pp 788-797 of In Physics of semiconductors. Pilkuhn, M.H. (ed.). Stuttgart; B. G. Teubner (1974).

From 12. international conference on the physics of semiconductors; Stuttgart, F.R. Germany (15 Jul 1974).

See CONF-740722—.

Electron delocalization is studied in n-CdS by observing the SFRS linewidths. A new effect is also described wherein simultaneous irradiation of the spins with laser light at frequency ω/sub L/ and microwaves at frequency ω_0 near the spin resonance results in forward scattering at ω/sub L/ +- ω_0 which is more than three orders of magnitude greater than spontaneous SFRS. (auth)

3495 X-ray and far-uv photoemission studies of amorphous As_2S_3, As_2Se_3, and As_2Te_3. Bishop, S.G. (Naval Research Lab., Washington, DC); Shevchik, N.J. pp 1017-1021 of In Physics of semiconductors. Pilkuhn, M.H. (ed.). Stuttgart; B. G. Teubner (1974).

From 12. international conference on the physics of semiconductors; Stuttgart, F.R. Germany (15 Jul 1974).

See CONF-740722—.

Photoemission spectra of amorphous As_2S_3, As_2Se_3, and As_2Te_3 reveal that the valence bands in these materials are more than 15 eV wide and exhibit a pronounced minimum at about 7 eV. The spectra indicate that the valence bands below this minimum are predominantly s-like and those above are mostly p-like; s-p hybridization is not extensive. (auth)

3496 Transverse thermal magnetoresistance of potassium. Newrock, R.S. (Univ. of Cincinnati); Maxfield, B.W. *J. Low Temp. Phys.;* **23**: No. 1/2, 119-142(Apr 1976).

Results are presented of extensive thermal magnetoresistance measurements on single-crystal and polycrystalline specimens of potassium having residual resistance ratios (RRR) ranging from 1100 to 5300. Measurements were made between 2

and 9°K for magnetic fields up to 1.8 T. The observed thermal magnetoresistance cannot be understood on the basis of either semiclassical theories or from the electrical magnetoresistance and the Wiedemann-Franz law. A number of relationships are observed between the thermal and electrical magnetoresistances, many of which are not immediately obvious when comparing direct experimental observations. The thermal magnetoresistance W(T,H) is given reasonably well by $W(T,H)T = W(T,0)T + AH + BH^2$, where both A and B are temperature-dependent coefficients. Results show that $A = A_0 + A_1T^2$, while B(T) cannot be expressed as any simple power law. A_0 is dependent on the RRR, while A_1 is independent of the RRR. Two relationships are found between corresponding coefficients in the electrical and thermal magnetoresistance: (i) the Wiedmann—Franz law relates A_0 to the Kohler slope of the electrical magnetoresistance and (ii) the temperature-dependent portions of the electrical and thermal Kohler slopes are both proportional to the electron—phonon scattering contribution to the corresponding zero-field resistance. The latter provides evidence that inelastic scattering is very important in determining the temperature-dependent linear magnetoresistances. Part, but by no means all, of the quadratic thermal resistance is accounted for by lattice thermal conduction. It is concluded that at least a portion of the anomalous electrical and thermal magnetoresistances is due to intrinsic causes and not inhomogeneities or other macroscopic defects.

3497 Current-induced breakdown of superconductivity in constricted type I superconducting films. Chimenti, D.E.; Watson, H.L.; Huebener, R.P. (Argonne National Lab., IL). *J. Low Temp. Phys.*; **23**: No. 3/4, 303-318(May 1976).

In simultaneous magneto-optical and electrical measurements on constricted type I superconducting films step structure in the current-voltage characteristic was correlated with the nucleation of individual flux-tube trains. A central feature of this experiment is the development of a sample geometry with which the breakdown behavior can be restricted to a single, localized flux-tube train running perpendicular to the transport current. Apparently, the step structure in the I—V characteristic results from a Gibbs free-energy barrier against the nucleation of flux-tube trains. The experiments are performed with films of lead and indium. From the I—V characteristics of the indium constrictions it is concluded that the flux-tube nucleation rate can vary substantially with applied current beyond a voltage step at temperatures near T/sub c/.

3498 New inhomogeneous state of superconducting films. Gray, K.E. (Argonne National Lab., IL). *J. Low Temp. Phys.*; **23**: No. 5/6, 679-686(Jun 1976).

Observations are reported of an inhomogeneous state consisting of alternating superconducting and normal regions which occurs upon exceeding the critical current density in thin granular aluminum films. The results are in quantitative agreement with recent theoretical predictions, based on a model in which only the superconducting and fully normal states are stable. It is found that the normal regions are maintained at a temperature above T/sub c/ by the heat dissipation due to the transport current. The breakdown occurs at critical currents smaller than predicted and is apparently a flux-flow instability brought about by a residual perpendicular field.

3499 Ultrasonic determination of the superconducting energy gap in high-purity tantalum. Reed, R.W.; Boyer, A.C. (Pennsylvania State Univ., University Park). *J. Low Temp. Phys.*; **24**: No. 1/2, 35-40(Jul 1976).

Ultrasonic attenuation measurements as a function of temperature were made for sound propagating along the [100], [110], and [111] crystal directions of Ta single-crystal specimens. Sound frequencies from 180 to 500 MHz were used with single crystals having residual ratios up to 3866. For the three propagation directions used, the superconducting energy gap had an average value of 1.77 kT/sub c/, which was within the experimental error for the three separate values of the gap parameter.

CORROSION AND EROSION

REFER ALSO TO CITATION(S) 2265, 2489

3500 (COO—2462-2) Pitting and stress corrosion cracking behavior of austenitic stainless steel weldments containing retained ferrite. Technical progress report No. 2, June 1, 1975—May 31, 1976. Duquette, D.J.; Savage, W.F. (Rensselaer Polytechnic Inst., Troy, N.Y. (USA). Dept. of Materials Engineering). 1976. Contract AT(11-1)-2462. 7p. Dep. NTIS $3.50.

The critical pH for pitting protection is 8.5 for weld metal, 11.5 for as-received 304L ss. Re-passivation potentials measured using potentiokinetic scanning and after long-term testing were found not to be reproducible and accurate. Slow-strain-rate stress corrosion cracking (SCC) tests of as-received and welded 304L and 304 ss were conducted in boiling $MgCl_2$ solutions. The decreased strain rate led to increased SCC, with the threshold being at $4 \times 10^{-6}s^{-1}$. 304L ss exhibited intergranular failure below 135°C and transgranular failure at 154°C. A specimen containing a transverse weld failed in the heat affected zone when tested in liquid paraffin; in boiling $MgCl_2$, the failure occurred in the fusion zone. In boiling saturated NaCl, SCC occurred in as-received ss only at pH less than 2.5 and slowest strain rate, and in weld metal only at pH less than 1.0 and slowest strain rate, but H_2SO_4 or HCl + NaCl induces susceptibility. (DLC)

3501 Energy-loss microscopy of ZrO_2. Ploc, R.A. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.); Ottensmeyer, F.P. *Micron;* **6**: No. 1-2, 65-72(1975).

A prism-mirror-prism energy filter installed in a transmission electron microscope was used to examine oxide films formed on zirconium. Bright and dark-field images were obtained using electrons which were elastically and inelastically scattered. Reproducible energy losses of 13.8, 23.9 and 37.9 eV were characteristic of the ZrO_2 films examined.

3502 Assessment of the progress of steel oxidation in gas cooled nuclear reactors by a remote measurement technique. Tozer, B.A. (Central Electricity Generating Board, Southampton (UK). Marchwood Engineering Labs.); Whittle, I. *J. Br. Nucl. Energy Soc.*; **15**: No. 1, 89-95(Jan 1976).

An instrument is described which has been developed for the measurement of oxide thickness on structural components in the nuclear core region of Magnox power stations. Using a ruby laser and a helium-neon laser the equipment can measure oxide thicknesses in the range from a few microns to more than a millimetre. The technique is essentially non-destructive and the equipment need not be in direct contact with components on which measurements are being made. The need for such an instrument, the technique of measurement, stability requirements and the methods of calibration are discussed. The performance of the instrument is illustrated using a set of in-pile results obtained at Oldbury nuclear power station in 1974. The future development potential is briefly discussed.

3503 Utility experience and planning in regard to pipe cracks in BWRs. Rossin, A.D. (Commonwealth Edison Co., Chicago); Webb, W.; Lapides, M.E. *Trans. Am. Nucl. Soc.*; **23**: 139-140(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3504 Steam generator tube performance in water-cooled reactors. Hare, M.G. (Chalk River Nuclear Labs., Ont.). *Trans. Am. Nucl. Soc.*; **23**: 140-142(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 2488, 3489, 4333

3505 (BNWL-CC—459) Tritium recovery from ceramic targets, interim report. Harmon, K.M. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 25 Jan 1966. 24p. Dep. NTIS $3.50.

Declassified 17 Feb 1976.

Aluminum-clad pellets of irradiated lithium aluminate are charged into a vacuum retort with anhydrous sodium tetraborate. As the temperature is raised, the aluminum melts away (approximately 650°C), the borax flux melts (approximately 740°C) and finally the pellets dissolve (approximately 850°C). During this period, the tritium and helium are released into the vacuum system where they are collected and purified. The cooled flux mixture is then discarded with its container. The recovery process is shown schematically. (JRD)

3506 (LA-UR—75-2353) Void growth suppression by dislocation impurity atmospheres. Weertman, J.; Green, W.V. (Los Alamos Scientific Lab., N.Mex. (USA)). 1976. Contract W-7405-ENG-36. 26p. (CONF-760515—1). Dep. NTIS $3.50.

From 8. symposium of the American Society for Testing and Materials on the effect of radiation on structural materials; St. Louis, Missouri, United States of America (USA) (4 May 1976).

A detailed calculation is given of the effect of an impurity atmosphere on void growth under irradiation damage conditions. Norris has proposed that such an atmosphere can suppress void growth. The hydrostatic stress field of a dislocation that is sur-

rounded by an impurity atmosphere was found and used to calculate the change in the effective radius of a dislocation line as a sink for interstitials and vacancies. The calculation of the impurity concentration in a Cottrell cloud takes into account the change in hydrostatic pressure produced by the presence of the cloud itself. It is found that void growth is eliminated whenever dislocations are surrounded by a condensed atmosphere of either oversized substitutional impurity atoms or interstitial impurity atoms. A condensed atmosphere will form whenever the average impurity concentration is larger than a critical concentration.

3507 (SAND—75-6189) **Depth distribution and migration of helium in vanadium at elevated temperatures.** Blewer, R.S.; Langley, R.A. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1976. Contract AT(29-1)-789. 24p. (CONF-760209—28). Dep. NTIS $3.50.

From 2. international conference on surface effects in controlled fusion devices; San Francisco, California, United States of America (USA) (16 Feb 1976).

The depth profiles and retention behavior of ^{4}He implanted at 80 keV into vanadium have been investigated in cold rolled bulk and foil samples. The specimens were implanted at temperatures of 100, 400, and 800°C and at fluences up to 1 x 10^{18} He/cm^2. Helium depth distributions were found to be Gaussian for the 100°C implants but exhibited a double peak appearance for some of the highest fluence 400 and 800°C implants. In polished samples blistering and flaking occurred at both 100 and 400°C implant temperatures for fluences greater than 5 x 10^{17} He/cm^2, but little of the implanted helium appeared to have been released as a result of the exfoliation. Conversely, most of the implanted helium was released from 800°C implant areas though no significant blistering or surface perforation was observed. Blistering was observed to occur only on polished samples, though the release behavior was similar to that of the unpolished specimens on which no blistering was observed at any temperature or fluence. The surface condition of samples polished by different techniques was found to exert an influence on the temperature dependence of release and on the character of the blister topography.

3508 Statistical fluctuations and dislocation climb during irradiation. Nichols, F.A.; Dollins, C.C. (Bettis Atomic Power Lab., Pittsburgh, Pa. (USA)). *Radiat. Eff.*; **27**: No. 1-2, 23-28(1975).

Most models proposed for radiation creep invoke means whereby a 'mismatch' exists in the fluxes of vacancies and interstitials arriving at a dislocation, thus effecting a net climb rate. Gittus has proposed a means of obtaining radiation creep even when vacancies and interstitials reach a dislocation in equal numbers. This model involves random climb due to statistical fluctuations in the arrival of point defects followed by glide of the dislocation when a critical climb height (up or down) is reached. A corrected analysis of this model is presented, using his variance approach. Also presented is a simpler analysis assigning a diffusivity to an individual dislocation segment and treating it as a random-walker. A more general discussion is included of the viable possibilities for the required mismatch in point defect fluxes during radiation creep.

3509 Irradiation embrittlement of steels in nuclear reactor vessels. Petrequin, P.; Soulat, P. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Recherches Metallurgiques Appliquees). pp 381-413 of In 17. Colloquium on metallurgy. Mechanical and metallurgical factors of fracture, particularly in nuclear industry. Saclay, 24-26 June 1974. Saclay, France; Institut National des Sciences et Techniques Nucleaires (1975). (in French)

From 17. Colloquium on metallurgy. Mechanical and metallurgical factors of fracture, particularly in nuclear industry; Saclay, France (24 Jun 1974).

Steels subjected to neutron irradiation undergo embrittlement. This phenomenon is especially important in ferritic steels, which exhibit a ductile transition. Neutron irradiation causes hardening (increased yield strength) combined with embrittlement, a rise in the transition temperature and a decrease in impact strength. After a brief examination of the major mechanisms responsible for this embrittlement, the results obtained with reactor vessel steels are presented: the effects of irradiation temperature and neutron dose, and the influence of the metallurgical characteristics of the materials (metallurgical structure, chemical composition). The problem of anticipating irradiation embrittlement is dealt with by examining the problem of specimen selection and testing methods to be employed together with the representativity of experimental irradiations.

3510 Effect of hydrogen on the low-temperature deformation properties of neutron-irradiated vanadium. Chen, C.C.; Arsenault, R.J. (Univ. of Maryland, College Park). *Metall. Trans., A*; **7A**: No. 1, 55-61(Jan 1976).

The influence of hydrogen on the low temperature deformation characteristics of neutron-irradiated vanadium single crystals has been investigated in compression in the temperature range from 77 to 550°K. The addition of hydrogen to neutron-irradiated vanadium causes a local perturbation in the temperature dependence of yield stress that is similar to unirradiated vanadium. A mechanism based on the stress induced reorientation of small hydrides by the stress fields of moving dislocations has been put forward to account for this observation. In contrast, the presence of hydrogen prior to irradiation results only in a general rise in the yield stress. The disappearance of the local perturbation is attributed to the trapping of hydrogen atoms to form stable complexes during irradiation, thereby eliminating the phenomenon of stress-induced reorientation of hydrides. The fact that the hydrogen does not reduce the thermal component of the yield stress implies that the cancellation of neutron-produced defects by hydrogen is unlikely. The effect of prestraining prior to neutron irradiation resulted in a reduction of the increase in the yield stress due to the neutron irradiation. This reduction is probably due to the fact that the additional dislocations provide an increased sink density.

3511 Void swelling in fast reactor materials: a metallurgical problem. Johnston, W.G.; Lauritzen, T.; Rosolowski, J.H.; Turkalo, A.M. (Corporate Research and Development, Schenectady, NY). *J. Met.*; **28**: No. 6, 19-24(Jun 1976).

LMFBR core materials must retain high strength and ductility for years while in the irradiation-hot sodium environment of the reactor. The problem of void swelling and the search for alloys with low swelling are discussed. Techniques used for simulating in-reactor swelling are described briefly. The swelling varies systematically with the Cr and Ni content of commercial alloys. It is concluded that swelling can be controlled by changing the major composition, by adding minor elements, and by modifying the microstructure (the last de-emphasized because of poor stability of the structures). 11 figures. (DLC)

3512 Strenght, hardness, and the microstructure relationship on the ductility of bcc metals and alloys. Moteff, J. (Univ. of Cincinnati). *Trans. Am. Nucl. Soc.*; **23**: 134-135(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3513 Scanning electron microscope examination of a type-316 stainless-steel cladding breach in an EBR-II Mark-II fuel element. Eikum, A.K.; Koenig, J.F.; Williamson, M.H. (Argonne National Lab., Idaho Falls, ID). *Trans. Am. Nucl. Soc.*; **23**: 135-136(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3514 Novel method for studying damage rate effects in ion-bombarded nickel. Whitley, J.B.; Wilkes, P.; Kulcinski, G.L. (Univ. of Wisconsin, Madison). *Trans. Am. Nucl. Soc.*; **23**: 136-137(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3515 Effect of irradiation on the ductility of zirconium-based alloys. Sabol, G.P.; McDonald, S.G. (Westinghouse Research Labs., Pittsburgh). *Trans. Am. Nucl. Soc.*; **23**: 137-138(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3516 Observed cladding response to LMFBR fuel rod design parameters. Rosa, J.M.; Hilbert, R.F. (General Electric Co., Sunnyvale, CA). *Trans. Am. Nucl. Soc.*; **23**: 147(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3517 Irradiation creep of solution-annealed type 304L stainless steel. McVay, G.L. (Argonne National Lab., Idaho Falls, ID). *Trans. Am. Nucl. Soc.*; **23**: 147-148(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3518 Measured internal gas-flow conductance of an operating GCFR fuel rod. Longest, A.W. (Oak Ridge National Lab., TN); Gat, U.; Conlin, J.A.; Campana, R.J. *Trans. Am. Nucl. Soc.*; **23**: 148-149(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3519 **Recent advances in delineation of the mechanism of intergranular attack in stainless steel by fission products.** Aitken, E.A.; Adamson, M.G. (General Electric Co., Sunnyvale, CA). *Trans. Am. Nucl. Soc.*; **23**: 153(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3520 **Chemical attack of cladding in mixed oxide fuel elements.** Johnson, C.E. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.*; **23**: 153-154(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3521 **Evolution of cladding attack in LMFBR type oxide fuel pins.** Weber, J.W.; Gibby, R.L.; Hata, D.C.; Weber, E.T. (Hanford Engineering Development Lab., Richland, WA). *Trans. Am. Nucl. Soc.*; **23**: 154-155(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3522 **Analysis of fuel-cladding chemical interaction in mixed-oxide fuel pins.** Weber, J.W.; Dutt, D.S. (Hanford Engineering Development Lab., Richland, WA). *Trans. Am. Nucl. Soc.*; **23**: 155-156(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

CERAMICS, CERMETS, AND REFRACTORIES

3523 (BNL—21638) **Perovskites and garnets.** Khattak, C.P.; Wang, F.F.Y. (Brookhaven National Lab., Upton, N.Y. (USA)). 1976. Contract E(30-1)-16. 173p. Dep. NTIS $6.75.

The preparation and properties of perovskites and garnets are reviewed. Data and information are presented on crystal chemistry, crystal structure, phase equilibria, electrical properties, optical properties, and mechanical properties. (JRD)

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 2457, 2458, 2779, 3463

3524 (COO—2713-1) **Effects of internal gas pressure and microstructure on the mechanisms of hot-pressing and swelling in ceramics. Progress report, June 1, 1975—March 31, 1976.** Solomon, A.A. (Purdue Univ., Lafayette, Ind. (USA)). Feb 1976. Contract E(11-1)-2713. 18p. Dep. NTIS $3.50.

Pressurization system components for studying the hot-pressing and swelling behavior of CoO were built. A vacuum furnace was modified so that dimensional changes can be continuously monitored during sintering under high vacuum. Chracterization of the CoO starting powders was initiated. A technique was developed to form geometrically uniform pellet compacts of high green density using low pressure punch and die pressing followed by high pressure isostatic compaction to obtain uniform green density. Preliminary sintering experiments were carried out at 1 atm in air, inert gas, and under vacuum with specimen deflection continuously monitored. Resulting microstructures were characterized using mercury porosimetry and quantitative optical microscopy. Drastic differences in sintering rates in vacuum and air were observed. (DLC)

3525 (LBL—5173) **SEM hot stage sintering of UO_2.** Miller, D.J. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jun 1976. Contract W-7405-Eng-48. 30p. Dep. NTIS $4.00.

Thesis.

The sintering of hyperstoichiometric uranium dioxide powder compacts, in the hot stage of a scanning electron microscope, was continuously monitored using 16 mm time lapse movies. From alumina microspheres placed on the surface of the compacts, shrinkage measurements were obtained. Converting shrinkage measurements into densification profiles indicates that a maximum densification rate is reached at a critical density, independent of the constant heating rates. At temperatures above 1350°C, the movement of the reference microspheres made shrinkage measurements impossible. It is believed the evolution of UO_3 gas from hyperstoichiometric UO_2 is the cause of this limitation.

3526 **Method for de-halogenating a composition containing halides as impurities.** Grossman, L.N.; Brigham, D.A. (to General Electric Co.). French Patent 2,238,667/E/. 23 Jul 1974. 6p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France); priority claim: 23 Jul 1973, USA. Addition to the French patent document 7124643.

A fast dehalogenation low-temperature method, consisting in heating the halide-containing composition up to a temperature of from 315 deg C to 870 deg C in a de-halogenating atmosphere containing a vaporized alcohol. That method can be applied to the generation of uranium dioxide.

3527 **Process for the preparation of fine grain metal carbide powders.** Gortsema, F.P. (to Union Carbide Corp.). US Patent 3,932,594. 13 Jan 1976. Filed date 28 Dec 1973. 10p.

Fine grain metal carbide powders are conveniently prepared from the corresponding metal oxide by heating in an atmosphere of methane in hydrogen. Sintered articles having a density approaching the theoretical density of the metal carbide itself can be fabricated from the powders by cold pressing, hot pressing or other techniques. 8 claims, no drawings.

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 3044, 3181

3528 (BNL—21641) **Physical realisation of n greater than or equal to 4 vector models.** Mukamel, D.; Krinsky, S.; Bak, P. (Brookhaven National Lab., Upton, N.Y. (USA); Cornell Univ., Ithaca, N.Y. (USA)). 1976. Contract E(30-1)-16. 10p. (CONF-760922—7). Dep. NTIS $3.50.

From International conference on magnetism; Amsterdam, Netherlands (6 Sep 1976).

Renormalization group analysis of several n greater than or equal to 4 systems was performed. The first-order transitions in Cr, Eu, UO_2, MnO, and TbP can be explained by noting that the Hamiltonians have no stable fixed-points in 4-epsilon dimensions. The phase transitions in $TbAu_2$, DyC_2, Tb, Ho, Dy, TbD_2, Nd, MnS_2, and K_2IrCl_6 are described by n greater than or equal to 4 Hamiltonians with a stable fixed point; critical exponents corresponding to this fixed point were calculated.

3529 (COO—2754-1) **Structure of glasses containing transition metal ions. Progress report, June 1, 1975—January 31, 1976.** Brawer, S.A.; White, W.B. (Pennsylvania State Univ., University Park (USA). Materials Research Labs.). Feb 1976. Contract E(11-1)-2754. 38p. Dep. NTIS $4.00.

Summarized is work on the structure of transition metal ion-containing silicate, borate, and other insulator glasses. Raman spectra were measured on lead silicate and on alkali-alkaline earth nitrate glasses. Raman spectra of lead silicate glasses are strongly polarized. The high frequency modes are greatly broadened with respect to alkali silicate glasses and new features appear in the low frequency region related to the lead concentration. The nitrate glass Raman spectra show broadened bands in more or less the positions expected from the molecular modes of the nitrate ions. The broadening and some splitting of these bands can be interpreted in terms of a distribution of local fields around the nitrate ions. An extensive series of chromium-containing silicate and borate glasses were prepared. Chromium appears in both Cr^{3+} and Cr^{6+} states. The Raman spectra show that hexavalent chromium exists in the glasses as molecular chromate or dichromate-like clusters. Cr^{6+} is not incorporated into the network. The local environment of Cr^{3+} was investigated by optical absorption and luminescence spectroscopy. The optical properties of Cr^{3+} in silicates were largely independent of base glass composition, which is not true of the borates. A study was begun on the local environment of iron in glasses through the optical absorption of Fe^{2+} and an observable red luminescence of Fe^{3+} which seems to be incorporated into the network. A characteristic yellow luminescence of very pure base glasses is also under investigation. 11 figures.

3530 (BNWL-tr—186) **Contribution to the physical and chemical knowledge of systems formed by uranium, oxygen, and a metallic element.** Bobo, J.C. Translated from *Rev. Chim. Miner.*; **1**: 1-15(1964). 17p. Dep. NTIS $4.00.

An investigation was made of the solid-state reactions in the ternary system U—Ca—O. The following compounds were formed: CaU_3O_7, $CaOU_4$, Ca_2UO_6, $CaUO_4$, and $CaUO_3$. The reactions were carried out in oxygen and in vacuum. (DLC)

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 3472

3531 **Transient deformation of oxide fuels.** Solomon, A.A. (Purdue Univ., West Lafayette, IN); Yust, C.S.; Packan, N.H. *Trans. Am. Nucl. Soc.*; **23**: 176(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 2459, 2460, 2461, 2462, 3182, 3486, 3488

3532 (COO—3151-61) **Anomalous thermal properties of glasses at low temperatures.** Salinger, G.L. (Cornell Univ., Ithaca, N.Y. (USA); Rensselaer Polytechnic Inst., Troy, N.Y. (USA)). 1976. 46p. Dep. NTIS $4.00.

It is shown that specific heat measurements above 0.1 K indicate a distribution of local modes independent of energy; ultrasonic attenuation at low powers indicate that the local mode systems can have at most a few levels; ultrasonic velocity measurements give information about phonon-local mode coupling parameters; the measured thermal conductivity agrees with that calculated from the above information assuming that the energy independent distribution of modes observed in the specific heat is responsible for phonon scattering; thermal expansion and far infrared experiments indicate a phonon assisted tunneling model; several experiments, however, indicate that the modes observed in the specific heat measurements may not all scatter phonons. (auth)

3533 (SAND—76-6029) **Current trends in the technology of electrooptic ferroelectric ceramics.** Shternberg, A.R. Translated by P. Newman from *Uch. Zap., Latv. Gos. Univ.*; **230**: 134-169(1975). 35p. Dep. NTIS $4.00.

The main reason for improving and optimizing the techniques of fabricating electrooptic ceramics is to improve their optical quality (transparency and optical homogeneity both in bulk and cross section). The current tendencies are to employ chemically coprecipitated raw materials, hot pressing under oxygen, and fabrication without hot pressing using a controlled atmosphere during sintering (O_2 and PbO). The current trend is toward fabrication of large-grain (scattering) ceramics. Such ceramics can be fabricated either by hot pressing, by atmospheric sintering, or by the two-stage process. At the present time the traditions of the individual research centers are playing an essential role in the choice of fabrication technique. But on transition to mass production on a large scale, which is probable in the coming years, economic factors will become increasingly significant (such as the duration of the process, the possibility of fabricating a large number of samples simultaneously, cost of the original components, reproducibility, etc.). At the present time the best results are achieved with PLZT ceramics.

3534 **Axial fuel redistribution by vapor transport in LMFBR fuel rods.** Harbourne, B.L.; McCarthy, W.H. (General Electric Co., Sunnyvale, CA). *Trans. Am. Nucl. Soc.*; **23**: 146-147(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3535 **Fuel-cladding gap-conductance model for LMFBR fuel elements.** Chow, L.S.H.; Billone, M.C. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.*; **23**: 170-171(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3536 **Pressure dependence of the superconducting transition temperature in alkali tungsten bronzes.** Bloom, D.; Shanks, H.R.; Barnes, J.; McKee, K.D.; Ostenson, J.E.; Finnemore, D.K. (Ames Lab., IA). *J. Low Temp. Phys.*; **23**: No. 5/6, 743-749(Jun 1976).

The superconducting transition temperatures have been measured for the tetragonal I phase of $Na_{0.23}WO_3$, the hexagonal phase of $K_{0.33}WO_3$, and the hexagonal phase of $Rb_{0.33}WO_3$ for pressures up to 20,000 bar. The slope of the curves is $+1.7 \times 10^{-5}$ °K/bar for the sodium bronze, -5.8×10^{-5} °K/bar for the potassium bronze, and -1.5×10^{-5} °K/bar for the rubidium bronze. A sharp change in slope of the transition temperature vs. pressure curve for the potassium bronze at 4000 bar may indicate a phase change.

CORROSION AND EROSION

REFER ALSO TO CITATION(S) 2476, 2535

3537 (Juel—1194) **Investigations of structure and texture dependent surface reactions between pyrocarbon and oxygen at room temperature.** Wolfrum, E.A. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorwerkstoffe und Heisse Zellen; Technische Hochschule Aachen (Germany, F.R.)). May 1975. 118p. (In German). INIS.

Thesis. 62 figs.; 17 tabs.; 102 refs.

Within the scope of general investigations on material properties of pyrocarbon coating layers on coated fuel particles, the chemical behaviour of the pyrocarbon surface and the processes occurring on them on a reaction with oxygen or atmosphere at room temperature were subjected to investigations. It has been the objective of this study to investigate the behaviour of the reaction as a function of surface properties of the solid and to develop, on the basis of these results, methods for a chemical characterization of pyrocarbon coating layers. The hydrogen peroxide concentration produced on the surface could be traced by fluorescence spectrometry in connection with the autoxidation reaction of N,N-dimethyl formamide. The concentration is proportional to the number of unpaired electrons of the pyrocarbon coating layers. The simultaneously produced basic surface oxides are a function of the disordered material of high inner surface. On this basis, a method has been developed by which the concentration of the tangled material in pyrocarbon coating layers can be determined quantitatively.

3538 **Diffusion-limited sulfidation of Wustite.** McCormick, S.; Dayananda, M.A.; Grace, R.E. (Illinois Inst. of Tech., Chicago). *Metall. Trans., B*; **6B**: No. 1, 55-61(Mar 1975).

The sulfidation of wustite in H_2S-H_2O-H_2-Ar atmospheres has been studied at temperatures of 700, 800, and 900°C with thermogravimetric techniques. Polycrystalline wustite wafers were equilibrated in a flowing H_2O-H_2-Ar gas stream and then sulfidized in situ. During an initial transient stage a protective layer of FeS formed on the sample, and an intermediate layer of Fe_3O_4 formed between the FeO and FeS layers. Subsequently, the reaction followed a parabolic rate law. The parabolic rate constant varied from 0.22×10^{-2} mg^2 cm^{-4} min^{-1} at 700°C to 6.5×10^{-2} mg^2 cm^{-4} min^{-1} at 900°C. The reaction rate was limited by the diffusion of iron through the intermediate Fe_3O_4 layer which grew concurrently with the FeS layer and at the expense of the FeO core. After the FeO core was completely converted to Fe_3O_4, the process entered a passive stage during which no further mass changes could be detected.

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 2534, 2819, 3488, 3518

3539 (ANL—75-66) **Facies of ion bombarded surfaces of brittle materials.** Primak, W. (Argonne National Lab., Ill. (USA)). Dec 1975. Contract W-31-109-Eng-38. 41p. Dep. NTIS $5.00.

Materials were bombarded by protons, deuterons, and helium ions. The materials investigated were quartz; glasses; carbides and borides (SiC, B_4C, TiB_2); oxides and nitrides (magnorite, sapphire, spinel, Al_2O_3, Si_3N_4, ZrO_2, $BaTiO_3$); and miscellaneous (graphite, $LiNbO_3$, copper). Oberservations were of growth, reflectivity, blistering, surface ablation, and swelling. Calculations were made of the effects of a layer, of its gradual transformation, and of the introduction of a gas. It is concluded that: Radiation blistering is not a primary process. Observations of blister formation and exfoliation cannot be used to calculate the surface ablation rate. The primary process is the development of a microporous layer which causes swelling. Visible blisters are caused by fracturing by transverse stresses in this layer and may occur during the bombardment, or in some cases, much later, in storage. There is no evidence of extreme gas pressures in the blisters. When blisters develop, they may be stable under continued bombardment for a dose many times that at which they formed. The swelling is a better index of the effects than is the blistering, and must be associated in most cases with permeability to the gas. Behavior with protons and deuterons is similar, with helium different. All but quartz, vitreous silica, and Pyrex are impervious to hydrogen and deuterium; only dense barium crown glass, carbides, borides, oxides, and nitrides are impervious to helium. Quartz shows swelling caused by conversion to a vitreous product of much lower density but no porosity, while for the others, most of the swelling and surface growth is caused by porosity. Surface ablation by the blistering process may be reduced by initial porosity or by initial or subsequent surface fissuring. However, for impervious materials, surface damage by the introduction of porosity would continue. (DLC)

3540 (CONF-760929—1) **Charge trapping and dielectric breakdown in lead silicate glasses.** Weeks, R.A.; Kinser, D.L.; Lee, J.M. (Oak Ridge National Lab., Tenn. (USA); Vanderbilt Univ., Nashville, Tenn. (USA)). 1976. Contract W-7405-Eng-26. 11p. Dep. NTIS $3.50.

From 4. international conference on physics of non-crystalline solids; Clausthal, German, Federal Republic of (F.R. Germany) (13 Sep 1976).

When irradiated with beams of energetic electrons or gamma rays, many insulating glasses and plastics exhibit a spon-

taneous electrical discharge producing permanent patterns in the materials (Lichtenberg figures). In the case of inorganic glasses, this effect is not observed in pure silicate, germanate, or phosphate glasses nor in their crystalline forms and has only been reported in mixed-oxide glasses with low alkali content. In a series of lead silicate glasses of composition [PbO]/sub (x)/[SiO_2]/sub [1-(x)]/, the effect is observed only for 0 less than x less than or equal to 0.40. Changes in electrical properties are related to structural changes in these glasses. Electron microscopy of these glasses confirms the existence of microphase separation in the range 0.2 less than or equal to x less than or equal to 0.5.

3541 (UCID—17199) **DT fusion neutron irradiation of BNL single crystal Al_2O_3, ORNL MgO crystal, and LASL 90° sapphire, O° sapphire, spinel, and YAG.** MacLean, S.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 15 Jun 1976. Contract W-7405-eng-48. 8p. Dep. NTIS $3.50.

These materials were stacked together for irradiation by the LLL rotating target neutron source. A description of the samples is included along with data on dosimetry. (JRD)

3542 Reirradiation of mixed-oxide fuel pins at increased temperatures. Lawrence, L.A.; Weber, E.T. (Hanford Engineering Development Lab., Richland, WA). *Trans. Am. Nucl. Soc.;* **23**: 143-144(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3543 Transport and reaction of volatile fission products in gas-cooled fast reactors. Johnson, C.E.; Johnson, I. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* **23**: 149-150(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3544 In-reactor fuel rod bowing characteristics. King, R.A.; Mayer, J.T.; Spaziani, J.C. (Babcock and Wilcox Co., Lynchburg, VA). *Trans. Am. Nucl. Soc.;* **23**: 150-151(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3545 Observations on the geometry of an irradiated rapsodie subassembly. Blanchard, P.; Leclere, J.; Ollier, H. (Centre d'Etudes Nucleaires de Calarache St. Paul lez Durance, France). *Trans. Am. Nucl. Soc.;* **23**: 151-152(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3546 Computer simulation of fission gas swelling behavior in carbide fuels. Prajoto; Wazzan, A.R.; Okrent, D. (Univ. of California, Los Angeles). *Trans. Am. Nucl. Soc.;* **23**: 170(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3547 Behavior of fission gas in LWR fuel during steady-state operating conditions. Rest, J. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* **23**: 171-172(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3548 Semiempirical model for radioactive fission gas release from UO_2. Beyer, C.E. (Battelle Pacific Northwest Labs., Richland, WA); Meyer, R.O. *Trans. Am. Nucl. Soc.;* **23**: 172-174(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3549 Nonequilibrium analysis of fission gas release and bubble freezing during fast transients. Griesmeyer, J.M.; Steele, W.G.; Okrent, D.; Chien, S.H.; Wassan, A.R. (Univ. of California, Los Angeles). *Trans. Am. Nucl. Soc.;* **23**: 174(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3550 Crack healing correlation predicting recovery of fracture strength in LMFBR fuel. Lovejoy, W.S.; Evans, S.K. (General Electric Co., Sunnyvale, CA). *Trans. Am. Nucl. Soc.;* **23**: 174-176(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3551 Boron carbide dilatation model for pressurized water reactor application. Knight, N.F. Jr. (Virginia Polytechnic Inst., and State Univ., Blacksburg). *Trans. Am. Nucl. Soc.;* **23**: 176-177(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

COMPOSITE MATERIALS

REFER ALSO TO CITATION(S) 3003

PHYSICAL PROPERTIES

3552 (ORNL/TM—5543) **Propagation of normal zones in composite superconductors.** Dresner, L. (Oak Ridge National Lab., Tenn. (USA)). Aug 1976. Contract W-7405-eng-26. 32p. Dep. NTIS $4.00.

This paper describes calculations of propagation velocities of normal zones in composite superconductors. Full accounting is made for (1) current sharing, (2) the variation with temperature of the thermal conductivity of the copper matrix, and the specific heats of the matrix and the superconductor, and (3) the variation with temperature of the steady-state heat transfer at a copper-helium interface in the nucleate-boiling, transition, and film-boiling ranges. The theory, which contains no adjustable parameters, is compared with experiments on bare (uninsulated) conductors. Agreement is not good. It is concluded that the effects of transient heat transfer may need to be included in the theory to improve agreement with experiment.

POLYMERS AND PLASTICS

PHYSICAL PROPERTIES

3553 (Y—2051) **Determination of the kinetics of curing and the heat capacity of an epoxy resin by differential scanning calorimetry.** Basford, J.A. (Oak Ridge Y-12 Plant, Tenn. (USA)). Aug 1976. Contract W-7405-eng-26. 30p. Dep. NTIS $4.00.

Two techniques were developed for determining the kinetic parameters of chemical reactions from differential scanning calorimeter data. In one technique, variation with time of the heat gain or loss as reactions proceed can be used to determine the order, rate constant, activation energy, and heat of reaction. In the second technique, variation with time of the glass transition temperature of certain materials can be used to determine the order, rate constant, and activation energy. An application has been made to the curing of an epoxy resin.

OTHER MATERIALS

REFER ALSO TO CITATION(S) 3541

PREPARATION AND MANUFACTURE

REFER ALSO TO CITATION(S) 2462, 3464

3554 (UCRL—52086) **Formation and evaluation of convex-curved crystals of lithium fluoride for use in analyzing x-ray spectra.** Sellick, B.O. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 22 Jul 1976. Contract W-7405-eng-48. 21p. Dep. NTIS $3.50.

Lithium fluoride as received from the vendor in boule form is 38 x 38 x 13 mm thick. This block is cleaved to wafers of the desired thickness, x-ray-evaluated for "d" spacing and greatest intensity, bent to the required radius, and then acid-etched to remove foreign material. The diffraction and dispersion characteristics of a wafer are analyzed using well-collimated tungsten x rays that strike the crystal and are diffracted onto no-screen x-ray film. If the crystal is satisfactory, it is mounted in a spectrogoniometer and rotated through an x-ray beam while a detector is set at the optimized angle for the diffracted x rays. The average intensity across the length of the crystal is recorded by multichannel scaling. Any imperfections appear as peaks or dips compared to the average intensity. The crystal next goes to a 10-channel, filter-fluorescer x-ray unit that compares zero-order intensity to diffracted $K\alpha$ and $K\beta$ intensity. Counts for 100-s intervals are taken in groups of three and averaged. Correction factors for instrument geometry, air, pinhole diameter at zero order, $K\alpha$-$K\beta$, barometric pressure, temperature, etc., are added to the efficiency calculations to obtain the crystal efficiency (epsilon) vs keV data.

The crystal is mounted in the spectrograph or spectrometer and calibrated to either the detector or film plane by using direct radiation with proper x-ray filters or absorbers. The crystal is then ready for use.

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 2531, 3280

PROPERTIES

REFER ALSO TO CITATION(S) 2516, 3490

3555 (AED-CONF—75-050-001) **Load bearing capacity and antiwear properties of non-Newtonian lubricants.** Ruedinger, V. (Kernforschungszentrum Karlsruhe (Germany, F.R.)). 1975. 11p. (In German). (CONF-750476—16). INIS.

From 6. scientific symposium of the German Society for Medical Physics; Berlin, F.R. Germany (28 Apr 1975).

5 figs.; 22 refs. With abstract in German and English.

Based on the continuous and very sensitive wear measurement with radiotracers an investigation about antiwear properties of non-Newtonian multigrade oils was carried out. Load capacity of a statically loaded journal bearing was much smaller than would be expected from low shear viscosity of the oil used. It was found that shear degradation didn't influence bearing load capacity. Non-Newtonian multigrade oils also caused higher liner wear rates in a 4-cylinder passenger car diesel engine running under full load, than Newtonian lubricants of the same nominal viscosity.

3556 (COO—3153-128) **First and second pressure derivatives of the elastic constants of CsBr crystals.** Dunn, K.J. (Cornell Univ., Ithaca, N.Y. (USA). Materials Science Center). Jan 1975. Contract E(11-1)-3153. 171p. Dep. NTIS $6.75.

Thesis.

The first and second pressure derivatives of the adiabatic elastic constants of CsBr single crystal were measured at 300, 298, 258.2, and 222°K using pulse interference techniques. The corresponding quantities of the bulk modulus of CsBr are also calculated. The maximum pressures used in the experiments ranged from 6 kbars to 11 kbars. B_0/sup T'/ is measured to an accuracy of approximately 5 percent, and B_0/sup S''/ to approximately 15 to 30 percent, assuming the systematic error is absent. It is found, however, the value of B_0/sup S''/ is strongly affected by the systematic error arising from the choice of model in fitting the data. The widely used quadratic fit is found inadequate for a maximum pressure of 10 kbars. The contribution from the third-order term $^1/_6$ $B''_0{}'P^3$ can not be neglected. The quasi-harmonic approximation is used to derive the theoretical equation of state. Several two- or three-parameter empirical equations of state are also discussed. Using the long-wave method and the present data, the phonon dispersion relation of CsBr is calculated and compared with the experimental results of neutron scattering. 14 tables, 34 figures, 74 references.

3557 (COO—3153-129) **Isothermal equation of state of a lithium fluoride single crystal.** Kim, K.Y. (Cornell Univ., Ithaca, N.Y. (USA). Materials Science Center). Jan 1975. Contract E(11-1)-3153. 112p. Dep. NTIS $5.50.

Thesis.

An isothermal equation of state of a LiF single crystal was determined from length change measurements of the specimen as a function of hydrostatic pressure up to approximately 7 kbars at 28 to 41°C. The length change was measured with an accuracy of approximately 500 A by using a Fabry Perot type He—Ne laser interferometer for a 1-m long specimen at temperatures constant to less than 0.002°C. Several two- and three-parameter equations of state were used in analyzing the measured pressure-volume data. The computer fit for each equation of state determines not only the value of its parameters but also the standard deviations associated with them and one dependent variable, either pressure or volume. With the parameters determined, the equations of state are extrapolated to approximately 5 megabars in order to see discrepancies. Using the Born model of ionic solids, two equations of state were derived both from a power law potential and from an exponential form for the repulsive energy of alkali metal halides and used to fit the pressure-volume data of a LiF single crystal. They are also extrapolated to approximately 5 megabars. The Birch's two-parameter equation and the Grover, Getting, and Kennedy equation are indistinguishable from the two equations of state derived from the Born model for pressures approximately equal to or less than 800 kbars within +-20 kbars. The above four equations of state also fit closely the Pagannone and Drickamer static compression data, the Christian shock wave data, and the Kormer et al. shock wave data. The isothermal bulk modulus and its first pressure derivative at atmospheric pressure and 28.83°C are 664.5 +- 0.5 kbars and 5.40 +- 0.18, respectively, in close agreement with those values ultrasonically measured by R. A. Miller and C. S. Smith. (auth)

3558 (ORNL/TM—5300) **Evaluation and summary of a study of the long-term multiaxial creep behavior of concrete.** Kennedy, T.W. (Oak Ridge National Lab., Tenn. (USA)). Dec 1975. Contract W-7405-Eng-26. 139p. Dep. NTIS $6.00.

The creep behavior of concrete subjected to triaxial compressive stresses and elevated temperature was evaluated. Strains were measured in cylindrical specimens subjected to 58 test conditions: 0—3600 psi compressions; curing times of 90, 183, and 365 days; two curing histories (air-dried and as-cast); and two temperatures (75 and 150°F). The 90-day-cwed specimens were loaded for 12 months, followed by 5-month recovery. The other specimens were uniaxially stressed to 600 or 2400 psi for 5.25 or 4.75 years at 75°F, followed by 77-day recovery. Strain measurements were made during the curing, loaded, and unloaded-recovery periods. This report describes the experiment setup and summarizes the results and recommendations. (DLC)

3559 **Demagnetization due to interconfiguration fluctations in the RE—Cu_2Si_2 compounds.** Sales, B.C.; Viswanathan, R. (Univ. of California, San Diego, La Jolla). *J. Low Temp. Phys.*; **23**: No. 3/4, 449-467(May 1976).

Magnetic susceptibility, resistivity, specific heat, and thermoelectric power measurements on $EuCu_2Si_2$, $YbCu_2Si_2$, $CeCu_2Si_2$, and $GdCu_2Si_2$ are presented. The first three compounds show a demagnetization of the 4f shell, while the fourth was studied to determine the "normal" magnetic and electronic properties for the RE—Cu_2Si_2 system. $YbCu_2Si_2$, $CeCu_2Si_2$, and $EuCu_2Si_2$ are found to exhibit similar lattice, electronic, and magnetic properties: an intermediate lattice constant; a magnetic susceptibility that is large and paramagnetic but neither shows order nor a Curie divergence; a large electronic specific heat coefficient; strong deviations from a simple T law in the high-temperature resistivity; and a large maximum in the thermoelectric power. The data are interpreted in terms of interconfiguration fluctuations (ICF), and a simple model is presented which can quantitatively explain the magnetic susceptibility and semiquantitatively predicts the specific heat. In addition, the model is in qualitative agreement with the resistivity and thermoelectric power data.

3560 **Specific heat of monoclinic Se at low temperatures.** Wu, C.T.; Luo, H.L. (Univ. of California, San Diego, La Jolla). *J. Low Temp. Phys.*; **23**: No. 3/4, 487-490(May 1976).

Specific heats of α monoclinic Se have been measured from 2 to 20°K. Excess specific heat was noted.

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 3539

CHEMISTRY

REFER ALSO TO CITATION(S) 3116

ANALYTICAL AND SEPARATIONS CHEMISTRY

REFER ALSO TO CITATION(S) 2295, 2325

3561 (UCRL—52047) **Sample file controller: functional description.** Crawford, R.W.; Ames, H.S. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 Apr 1976. Contract W-7405-Eng-48. 34p. Dep. NTIS $4.00.

This report describes a Sample File Controller designed for the analytical laboratories of the Environmental Protection Agency. At the heart of the system is a computer program that aids in tracking and controlling the various stages of the sampling operation—planning the sampling, taking the samples, analyzing them, and reporting the results. The necessary input data are described, such as sample locations and parameters, automated and manual analytical results, and pertinent field data. The various outputs are shown, including work-load listings, interim status reports, and complete summary reports. Examples of possible operator-computer dialogs are used extensively, as well as examples of computer outputs. All the data that must be stored are described in appendices.

ACTIVATION AND NUCLEAR REACTION PROCEDURES

REFER ALSO TO CITATION(S) 2552, 2553

3562 (LBL—5017) **Archaeologist looks at x-ray fluorescence vs. neutron activation analysis.** Artzy, M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Apr 1976. Contract W-7405-ENG-48. 16p. (CONF-760353—1). Dep. NTIS $3.50.

From Applications of science to medieval ceramics conference; Berkeley, California, United States of America (USA) (18 Mar 1976).

X-ray fluorescence (XRE) and neutron activation analysis (NAA) are compared; a periodic table of the elements showing their sensitivity to each method is included. It is proposed to use both methods to make chemical abundances measurements on archaeological samples, including Bichrome Ware and Palestinian samples. The intent is to see if NAA can be replaced by XRF. (DLC)

3563 (SAND—76-0254) **Neutron activation analysis: tabulation of cross sections, Q-values, decay characteristics, and sensitivities.** Kenna, B.T.; Harrison, P.E. (Sandia Labs., Albuquerque, N.Mex. (USA)). Jul 1976. Contract E(29-1)-789. 90p. Dep. NTIS $5.00.

Tabulations are given for thermal activation analysis in a reactor operated in either a steady state or pulsed mode and for the accelerator produced 14 MeV neutron reactions, (n,2n), (n,p), (n,α), and (n,γ). This compilation gives target and product isotopes by chemical symbol and mass number, percentage abundance of the isotopes, the mass of the target isotope in amu (based on ^{12}C = 12.000000), reaction cross sections, half-life, decay characteristics, Q-values, and an indication of sensitivities.

3564 **Depth profiling of hydrogen and helium isotopes in solids by nuclear-reaction analysis.** Boettiger, J. (Univ. of Aarhus, Denmark); Picraux, S.T.; Rud, N. *Trans. Am. Nucl. Soc.*; **23**: 97-98(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3565 **Depth profiling of hydrogen and helium isotopes using ion beams.** Langley, R.A. (Sandia Labs., Albuquerque, NM). *Trans. Am. Nucl. Soc.*; **23**: 98-99(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3566 **Observations of ^3He and ^2H in solids using the $^3He(d,P)^4He$ reaction.** Pronko, P.P. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.*; **23**: 99(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3567 **High-resolution depth profiling of oxygen and carbon in materials by spectral deconvolution.** Schulte, R.L. (Grumman Aerospace Corp., Bethpage, NY). *Trans. Am. Nucl. Soc.*; **23**: 99-100(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3568 **Studying surface phenomena with charged particle reactions.** Tombrello, T.A. (California Inst. of Tech., Pasadena). *Trans. Am. Nucl. Soc.*; **23**: 100(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3569 **Surface analysis in metals by means of neutron spectrometry.** Lorenzen, J. (AB Atomenergi, Nykoping, Sweden). *Trans. Am. Nucl. Soc.*; **23**: 100-101(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

CHEMICAL PROCEDURES

REFER ALSO TO CITATION(S) 2419, 2441, 2446, 2549, 3562

3570 (ARH-SA—241) **Comparison of four methods for determining aluminum in highly radioactive solutions.** Hanson, T.J. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). Jun 1976. Contract E(45-1)-2130. 32p. (CONF-760661—1). Dep. NTIS $4.00.

From Rocky Mountain regional meeting of the American Chemical Society; Laramie, Wyoming, United States of America (USA) (17 Jun 1976).

Four methods for the accurate determination of aluminum in highly alkaline nuclear waste solutions were developed and the results were compared to determine the strengths and weaknesses of each. The solutions of interest contain aluminum in concentrations of 0.5 to 3.5 M and the hydroxide (OH^-) concentrations were greater than 1.0 M. The normal atomic absorption determination was highly inaccurate for these samples so citrate was used as a complexant to improve the results. A fluoride titration was carried out in an ethanol-water matrix using a fluoride ion-selective electrode. A thermometric titration proved successful in determining both the OH^- and aluminum concentrations of the samples. Finally, a titrimetric method using a pH electrode to determine OH^- d aluminum was checked and compared with the other methods. Samples were analyzed using all four methods and the agreement of the results was very good. For all four methods the accuracy was around 100 percent and the precision varied from approximately +-2 percent for the fluoride electrode determination to approximately +-10 percent for the atomic absorption determination. On the basis of the work performed, conclusions were drawn about the strengths and weaknesses of each method and whether or not the method was suitable for routine use in analytical laboratories.

3571 (ARH-SA—249) **Determination of dibutylbutylphosphonate in the presence of tributylphosphate by gas liquid chromatography.** Johnson, S.J. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). May 1976. Contract E(45-1)-2130. 25p. (CONF-760668—1). Dep. NTIS $4.00.

From 31. annual northwest regional American Chemical Society meeting; Reno, Nevada, United States of America (USA) (14 Jun 1976).

A gas chromatographic determination of dibutylbutylphosphonate in the presence of tributylphosphate was developed. The separation was done on a 183 cm by 3 mm stainless steel column packed with 10 percent Carbowax 20M—TPA on 80/100 mesh Chromosorb W AW and detected by flame ionization. A nitrogen carrier gas flow of 40 cm^3/min and an oven temperature of 180°C produced optimum resolution and column efficiency. The use of temperature programming reduced retention times and thus analysis time. An internal standard of 10 percent v/v n-tridecane was added to all samples and standards.

3572 (SRO—854-7) **Chromatographic determination of the relative retention of isotopic species of oxygen in methanol and methan-d^3-ol.** Pauls, R.E.; Mahle, N.H.; Shepard, A.T.; Gaw, J.C.; Rogers, L.B. (Georgia Univ., Athens (USA). Dept. of Chemistry). Aug 1976. Contract E(38-1)-854. 26p. Dep. NTIS $4.00.

A high-precision gas chromatograph was used in conjunction with a quadrupole mass filter and an on-line computer to study the fractionation of oxygen isotopes by Porapak T and glycerol in CH_3OH and CD_3OH as a function of temperature. Values of relative retention on the order of 1.002 compared favorably with results for the vapor pressure ratio obtained by classical means. Differences from unity were much smaller for the activity-coefficient ratio than for the vapor-pressure ratio. Differential thermodynamic data were also reported.

3573 (ORNL-tr—4212) **New color reaction for protein and arginine.** Sakaguchi, S. Translated by M. Gerrard from *J. Biochem. (Tokyo)*; **5**: 25-31(1925). 5p. Dep. NTIS $3.50.

Addition of naphthol and sodium hypochlorite solutions to an alkaline solution of arginine or protein results in a red color. The sensitivity is 1:50,000 for protein and 1:1,000,000 for arginine. Of the similar compounds investigated, only glycoseamine and α-guanidinebutyric acid give the same color reaction, indicating that the reaction is due to the intact guanidine residue of arginine. The pigment composition was determined to be $C_{28}H_{18}N_5ClO_4$. Guanidine (0.1 mg) can also be detected if its carbonate + glycocol is heated with water to form glycoseamine. (DLC)

RADIOMETRIC AND RADIOCHEMICAL PROCEDURES

REFER ALSO TO CITATION(S) 2464, 3487, 3748, 3754, 3774

3574 (ARH-SA—248) **In situ measurement of residual plutonium.** Kindle, C.H. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). 30 Jun 1976. Contract E(45-1)-2130. 21p. (CONF-760615—12). Dep. NTIS $3.50.

From 17. annual meeting of the institute of nuclear materials management; Seattle, Washington, United States of America (USA) (23 Jun 1976).

Nondestructive assay techniques were developed and implemented to permit the measurement of residual plutonium in glove boxes, conveyors, and tanks in areas of varying background using both gamma and neutron portable detection equipment. The gamma detector was a 2 x 2 inch sodium iodide detector collimated to view a well defined area. The neutron detector consisted of ^3He tubes in a polyethylene case with a small amount of

directionality. Application of the described techniques to equipment prior to removal has shortened the clean-up time by identifying the locations of recoverable quantities. The agreement between assigned values and recovered plutonium has been within 16 percent for quantities ranging from several grams up to kilogram levels.

3575 (ICP—1094) **Isotope dilution analysis of picogram quantities of Pu, Am, and Cm in nuclear fuel processing plant waste streams.** Baker, J.D.; McIsaac, L.D. (Allied Chemical Corp., Idaho Falls, Idaho (USA). Idaho Chemical Programs - Operations Office). Jun 1976. Contract E(10-1)-1375. 25p. Dep. NTIS $3.50.

Analytical procedures have been developed for the isotope dilution analysis of picogram levels of Pu, Am, and Cm in Idaho Chemical Processing Plant (ICPP) waste streams, which are highly beta-gamma active and contain bulk quantities of Zr, Al and F^-. Pu is initially separated by sequential coprecipitation using LaF_3 and $La(OH)_3$, and final purification is based on the separation of Pu(IV) by anion exchange. The Pu fraction is amenable to two isotope dilution analysis options; alpha spectrometry and mass spectrometry using ^{236}Pu and ^{242}Pu respectively, as the spike isotopes. Am and Cm are quantitively separated from macro quantities of Zr, Al and F^- by solvent extraction using di-(2-ethylhexyl) orthophosphoric acid (HDEHP). For Am the subsequent separation steps are tailored to the multiple isotope dilution analysis options which have been developed: mass spectrometry, gamma-ray spectrometry and alpha spectrometry, all of which use ^{243}Am as the spike isotope. Because Cm is present in small quantities, it is measured by alpha spectrometry relative to Am. Specific details relating to the subsequent separation steps and comparative precision data for the various analysis techniques are given.

3576 **Californium-252 plasma desorption mass spectroscopy.** Macfarlane, R.D.; Torgerson, D.F. (Texas A and M Univ., College Station). *Science;* **191**: No. 4230, 920-925(5 Mar 1976).

This method uses energetic fission fragments from ^{252}Cf decay to volatilize and ionize a solid sample. After an ion is formed, it is accelerated into a time-of-flight tube. Mass spectra of quasi-molecular ions can be produced for a wide variety of compounds, such as amino acids, peptides, nucleotides, etc. The method is nondestructive, and fragmentation patterns are obtained which can yield structure information. Sensitivity is presently at the nanogram level, and mass resolution is sufficient to give elemental identification up to mass 500. The mass range of molecules that can be studied could be as high as greater than or equal to 3000. (DLC)

SPECTRAL PROCEDURES

REFER ALSO TO CITATION(S) 2333, 2457, 3570

3577 (UCRL—52046) **Technicon autoanalyzers: functional description.** Crawford, R.W.; Barton, G.W. Jr. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 Apr 1976. Contract W-7405-Eng-48. 37p. Dep. NTIS $4.00.

This document describes and specifies a computer automation system for the Technicon AutoAnalyzers (I, II, and CSM-6 colorimeter). Operator inputs and interaction during the analysis run are described. Computer outputs during and at the end of the run are described and illustrated. The computer calculates concentrations, monitors quality control, and prepares reports.

3578 **^{148}Nd analysis for burnup determination in thermal reactor fuel elements.** Baraniak, L. (Zentralinstitut fuer Kernforschung, Rossendorf bei Dresden (German Democratic Republic)); Zahn, H. (Akademie der Wissenschaften der DDR, Leipzig. Zentralinstitut fuer Isotopen- und Strahlenforschung). *Kernenergie;* **19**: No. 1, 5-8(1976). (In German).

Burnup studies on fuel elements of the WWR-S type Rossendorf research reactor and of the WWER type Rheinsberg nuclear power reactor have been carried out on the basis of the ^{148}Nd method. Nd was isolated from the fuel fission products in nitric acid solution using a two-stage ion exchange procedure. First, the group of fission rare earth elements including Am and Cm was sorbed on Wofatit SBW from methanolic solution. Then, the rare earth elements were separated by α-hydroxy isobutyric acid on Wofatit KPS. During elution, the stable Nd fraction was found by gamma measurements of the directly preceding ^{241}Am. The ^{148}Nd content was determined by mass-spectrometric isotope dilution analysis using ^{150}Nd. The fuel burnup data obtained by means of the Nd method are compared with those obtained by means of other burnup monitors.

3579 **Comparison of interelement effects in a microwave single electrode plasma and in a radiofrequency inductively coupled plasma.** Larson, G.F.; Fassel, V.A. (Ames Lab., IA). *Anal. Chem.;* **48**: No. 8, 1161-1166(Jul 1976).

The results of a comparative study on the extent to which various interelement or interference effects are observed in a microwave-excited, single-electrode plasma (SEP) and a radiofrequency-excited, inductively coupled plasma (ICP) are presented. These studies confirmed earlier reports that easily ionizable elements generally produce severe changes on the line emission of analyte elements in the SEP, whereas only negligible or small effects are observed in the ICP. It is also shown that several concomitants with differing ionization potentials produce significant changes in the emission intensity of Mo in the SEP although only small effects are observed in the ICP and that PO_4^{3-} or Al^{3+} concomitants produce significant interference on calcium atomic and ionic line emission in the SEP while negligible effects are observed in the ICP.

3580 **Isotope dilution assay of boron-10 enriched elemental boron by mass spectrometry.** Inlow, R.O.; Scarborough, J.M. (New Brunswick Lab., NJ). *Anal. Chem.;* **48**: No. 9, 1357-1362(Aug 1976).

Boron-10 enriched elemental boron is assayed for total boron by mass spectrometric isotope dilution. Samples are fused with a sodium carbonate flux, dissolved in water, and spiked with National Bureau of Standards boric acid, which is certified for boron content as well as isotopic abundance. The mixture is converted to sodium tetraborate and analyzed isotopically by thermionic emission of the $Na_2BO_2^+$ ion. The method is not biased with respect to titrimetric assay. Replicate determinations have a relative standard deviation less than 0.1 percent.

3581 **Systematic errors in gas chromatography: mass spectrometry isotope ratio measurements.** Matthews, D.E.; Hayes, J.M. (Indiana Univ., Bloomington). *Anal. Chem.;* **48**: No. 9, 1375-1382(Aug 1976).

The mass cycling error, a systematic bias inherent in isotope ratio measurements carried out by switching ion beams which are time-variable, is systematically explored in a series of trial calculations, and the validity of these calculations is demonstrated experimentally using a typical gas chromatography-mass spectrometry system. The effects of varying measurement conditions are considered in terms of chromatographic peak profiles, relative ion-beam integration times, delays required for ion-beam positioning, unidirectional vs. bidirectional scanning patterns, and chromatographic fractionation of the isotopes. It is concluded that the unidirectional scanning pattern (ABCABC...) is superior to the bidirectional pattern (ABCCBA...), and that, in the absence of chromatographic fractionation of the isotopes, a bias of less than 1 percent can be obtained by its use for ten or more cycles on any given gas chromatographic peak. Under these same conditions, 35 or more observation cycles are required to bring the bias below 0.1 percent.

3582 **Inductively coupled plasmas as atomization cells for atomic fluorescence spectrometry.** Montaser, A.; Fassel, V.A. (Ames Lab., IA). *Anal. Chem.;* **48**: No. 11, 1490-1499(Sep 1976).

Inductively coupled plasmas (ICP) offer promise as atomization cells for atomic fluorescence spectrometry (AFS). In this study, an ICP formed part of a modular spectroscopic system for atomic fluorescence, emission, and absorption measurements. Details on the assembly of the complete system are provided. Microwave-excited, thermostated, electrodeless discharge lamps were used as primary sources for exciting the atomic fluorescence. A minicomputer provided control of radiofrequency (RF) forward power and site of observation in the plasma, as well as data acquisition and processing. The effects of important variables on the plasma background, the atomic fluorescence signal, and signal-to-noise ratio were examined. Scattering and matrix effects were also evaluated. The atomic fluorescence powers of detection for Cd, Zn, and Hg were found to be superior to those observed in emission when the same experimental facilities were used for the measurements.

SEPARATION PROCEDURES

REFER ALSO TO CITATION(S) 2500, 3581

3583 **Solvent extraction of Fe(III) by chlorendic acid.** Berger, S.A. (City Univ. of New York, NY); McKay, J.B. *J. Inorg. Nucl. Chem.;* **37**: No. 12, 2565-2567(Dec 1975).

From 8. annual middle Atlantic regional meeting of the American Chemical Society; Washington, DC (15 Jan 1973).

The properties of chlorendic acid, a hexachloro substituted norbornyl 1,2-dicarboxylic acid, are enumerated for the extraction of Fe(III).

3584 **Extraction of lithium from neutral salt solutions with fluorinated β-diketones.** Seeley, F.G.; Baldwin, W.H. (Oak Ridge National Lab., TN). *J. Inorg. Nucl. Chem.;* **38**: No. 5, 1049-1052(1976).

Lithium was selectively extracted from near-neutral aqueous solutions of alkali metal salts. The mechanism by which this was achieved involves the formation of the trioctylphosphine oxide adduct of a lithium chelate of a fluorinated β-diketone, which is then readily extractable into an organic diluent. High separation factors were obtained from sodium, potassium, rubidium, and cesium. The selectivity of the fluorinated β-diketones for lithium over the alkaline earths was found to be poor. A suggested general flowsheet for the recovery of lithium from a salt brine concentrate is included.

3585 Separation of metal ions using a hexylthioglycolate resin. Moyers, E.M.; Fritz, J.S. (Ames Lab., IA). *Anal. Chem.;* **48**: No. 8, 1117-1120(Jul 1976).

The synthesis, characterization, and some analytical applications of a new chelating resin are described. The new resin, HTG-4, is synthesized from a highly cross-linked, macroporous resin (XAD-4) and contains the hexylthioglycolate functional group. HTG-4 is highly selective for silver(I), mercury(II), bismuth(III), and gold(III) in acidic-aqueous solution. The first three metal ions are sequentially eluted with 0.5 to 6 M hydrochloric acid, and gold(III) is eluted with a thiourea solution. Several quantitative analytical separations are reported.

3586 Copper(II) salts as amine abstractors in gas chromatography. Chriswell, C.D.; Kissinger, L.D.; Fritz, J.S. (Ames Lab., IA). *Anal. Chem.;* **48**: No. 8, 1123-1126(Jul 1976).

An effective amine abstractor for use in gas chromatography was prepared by coating Chromosorb G AW/DMCS with copper(II) chloride. Other abstractor materials prepared were less effective. Pre-columns containing copper(II) chloride coated Chromosorb G retained all amines tested and had negligible effects on the separation of other types of compounds on analytical columns. Attractive properties of amine abstractors were demonstrated by separating pyridine solutions of alcohols, ketones, halogenated hydrocarbons, alkanes, alkenes, and aromatic hydrocarbons on appropriate analytical columns with and without the use of amine abstractor pre-columns. Applications of the abstractor were demonstrated in methods for determining volatile components in coal, on modifications of the resin sorption method for determining part-per-billion concentrations of organic impurities in water, and for determining impurities in reagent grade pyridine.

3587 N-oxides of 4-(5-nonyl)pyridine and trioctylamine as extractants for zirconium from uranium and fission product nuclides. Ejaz, M. (Pakistan Inst. of Nuclear Science and Tech., Nilore). *Anal. Chem.;* **48**: No. 8, 1158-1161(Jul 1976).

The solvent extraction of zirconium(IV) by 4-(5-nonyl)pyridine oxide and trioctylamine oxide has been studied from nitric, hydrochloric, and sulfuric acid solutions using a tracer technique. The dependence of extraction on the type of N-oxide, acid concentration, and N-oxide concentration has been investigated. The influence of the concentration of salting-out agents is described. Separation factors for a number of metal ions are reported, and the separation of zirconium from uranium fission product elements has been achieved.

3588 Method to reduce noise in silver nitrate—benzyl cyanide columns. Wampler, F.B. (Los Alamos Scientific Lab., NM). *Anal. Chem.;* **48**: No. 11, 1644-1645(Sep 1976).

For the gas chromatographic separation and determination of the isomeric 2-pentenes, $AgNO_3$ using benzyl cyanide as solvent were found to be superior to other solvents. Noise from column bleed (signal from eluting solvent) can be prevented by inserting a 12-ft length of an 8 percent DC-550 silicone oil column between the detector and the $AgNO_3$ column. (DLC)

INORGANIC AND PHYSICAL CHEMISTRY

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

REFER ALSO TO CITATION(S) 3287, 3556, 3557, 3610

3589 (BNL—21675) **One-dimensional magnetic variety in a family of TTF-bis-dithiolene metal complex compounds.** Bonner, J.C.; Jacobs, I.S.; Hart, H.R. Jr.; Interrante, L.V.; Watkins, G.D.; Prober, D.E.; Wolf, W.P. (Brookhaven National Lab., Upton, N.Y. (USA); General Electric Co., Schenectady, N.Y. (USA); Lehigh Univ., Bethlehem, Pa. (USA); Yale Univ., New Haven, Conn. (USA)). 1976. Contract E(30-1)-16. 11p. (CONF-760922—8). Dep. NTIS $3.50.

From International conference on magnetism; Amsterdam, Netherlands (6 Sep 1976).

The donor-acceptor compounds $TTF.MS_4C_4(CF_3)_4$, where TTF = tetrathiafulvalene and M = Cu, Au, Pt, Ni, are mixed-stack quasi-one-dimensional magnetic insulators of remarkable variety. For M = Cu, Au, a novel progressive spin-lattice dimerization occurs (spin-Peierls transition). For M = Pt, Ni, ferro/ferrimagnetic chains develop with moderate/weak antiferromagnetic coupling.

3590 (LBL—5196) **Attempts to prepare nitrosyl azid and a study of the decomposition of nitrosyl cyanide.** Illige, J.D. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jul 1976. Contract W-7405-ENG-48. 78p. Dep. NTIS $5.00.

Thesis.

The synthesis of nitrosyl azide has been attempted using a wide variety of reagents and techniques. Neither matrix isolation nor mass spectral studies of co-condensed hydrazoic acid and nitrosyl chloride provided any evidence for the formation of nitrosyl azide. No evidence has been found to substantiate a claim that nitrosyl azide exists as a moderately stable compound. Nitrosyl cyanide has been made by a slight variation of published methods, a method of purification established, and the decomposition studied. In the dark at room temperature or 75° and at moderate pressures of nitrosyl cyanide, the decomposition products of nitrosyl cyanide which was labeled with nitrogen 15 on the cyanide nitrogen were consistent with two mechanisms occurring simultaneously. Each mole of nitrosyl cyanide decomposed to 1/3 mole each of nitrogen, nitrous oxide, cyanogen, and carbon dioxide.

3591 (LBL—5207) **Gravimetric adsorption study of hydrogen and carbon monoxide on a supported ruthenium catalyst.** Bollinger, W.A.; Bell, A.T. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). May 1976. Contract W-7405-ENG-48. 89p. Dep. NTIS $5.00.

Thesis.

The adsorption kinetics and equilibrium uptake of hydrogen and carbon monoxide have been measured gravimetrically for a 4 wt percent ruthenium/silica catalyst. These measurements were performed over a temperature range of 20 to 250°C. The results were used to evaluate the catalyst-adsorbate interactions. Hydrogen adsorption was also used to determine the metal surface area and crystallite size. The adsorption isotherms of hydrogen were used to determine the heat of adsorption for hydrogen on ruthenium. A low heat of adsorption indicating a weak interaction of hydrogen with the metal surface was found for surface coverages greater than half a monolayer. The adsorption isotherms were found to be composed of two portions, reversible and irreversible hydrogen. Reversible hydrogen could be desorbed by evacuation of the catalyst at the adsorption temperature, while irreversible hydrogen could not be desorbed under these same conditions. The rate of hydrogen adsorption was found to follow the Elovich equation. Thermal desorption spectra revealed that at least two forms of hydrogen exist on the ruthenium surface. The carbon monoxide adsorption isotherm could also be divided into reversibly and irreversibly adsorbed components. The heats of adsorption for carbon monoxide obtained indicate a strong binding of the adsorbate to the ruthenium surface. Comparison of carbon monoxide and hydrogen isotherms indicates that the catalyst surface is permanently altered by carbon monoxide adsorption.

3592 (UCID—17159) **Aqueous LiOH: physical thermodynamic, and transport properties.** Homsy, R.V. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 5 Jun 1976. Contract W-7405-ENG-48. 23p. Dep. NTIS $4.00.

Experimental data in the literature on the physical, thermodynamic, and transport properties of aqueous LiOH are summarized. The behavior of some properties is predicted beyond the range of the data. 12 fig, 14 tables, 20 references.

3593 (ORNL-tr—4184) **Cause of the deviation from the Paschen law in SF_6.** Zaengl, W.; Baumgartner, R. Translated by E.G. Silver from *Elektrotech. Z., A;* **96**: No. 11, 510-514(1975). 19p. Dep. NTIS $3.50.

The measured Paschen curves in sulfur hexafluoride exhibit an abnormal functional dependence for high products of gas pressure and electrode gap distance. It is shown that this effect can be assigned with great certainty, and almost exclusively to the surface roughnesses of the electrodes, which are themselves produced by the breakdown process itself. The abnormal Paschen dependence may be calculated by application of the well-known streamer theory, taking into account the perturbed field configuration, whereby even an approximate modeling of the field strength configuration at the electrodes leads to good agreement of measured and calculated values.

3594 Experimental studies on sodium chemistry. Ullmann, H.; Teske, K.; Kuenstler, K.; Betzl, K.; Irmisch, R.; Rettig, D.; Richter, W.; Reetz, T. (Zentralinstitut fuer Kernforschung, Rossendorf bei Dresden (German Democratic Republic)). *Kernenergie;* **19**: No. 1, 13-17(1976). (In German).

Within the framework of the CMEA research programme on sodium cooled fast reactor development the Central Institute of Nuclear Research at Rossendorf is engaged in studies on sodium chemistry. The following problems are under investigation: development of methods for the control of impurities in sodium loops, studies on the behavior of impurities in sodium. The present status of these investigations is described. Available experimental equipment includes a 1.5 l sodium loop for radioactive studies as well as devices for sampling and analysis of sodium.

3595 Anhydrous hydrogen fluoride: Raman spectrum of the liquid. Sheft, I.; Perkins, A.J. (Argonne National Lab., IL). *J. Inorg. Nucl. Chem.*; **38**: No. 4, 665-668(1976).

The Raman spectrum of liquid hydrogen fluoride has been measured at a series of temperatures between -34.1°C and 49°C. Complex bands were found at displacements of 150, 400 to 700, 1000 to 1300 and 3000 to 3600 cm^{-1}. The intensity distribution within each of these bands is markedly temperature dependent. From the complexity of the temperature dependence and previously reported vapor density data, we conclude that a model involving all polymer species will be shown to be more correct than a model greatly emphasizing the hexamer.

3596 Thermodynamics of silver sulfate solubilities in aqueous sulfuric acid and sodium nitrate solutions, 0 to 60°C. Marshall, W.L.; Slusher, R. (Oak Ridge National Lab., TN). *J. Inorg. Nucl. Chem.*; **38**: No. 5, 279-285(1976).

In order to test further the adherence of solubility products of a 1-2 metal sulfate to an extended Debye—Hueckel equation, solubilities of Ag_2SO_4 in $NaNO_3$—H_2O and H_2SO_4—H_2O solutions were determined from 0 to 60°C. These data, agreeing with those at 25°C in the literature, were evaluated to obtain solubility products (Q/sub sp/) at the several ionic strengths by use of second ionization constants of bisulfate ion (K_2) and an iterative process. Values of Q/sub sp/ fitted well to an extended Debye—Hueckel equation, yielding solubility product constants (K/sub sp/) at 0.4 to 60°C. These values agreed with those of Lietzke and Stoughton at 25 to 200°C when both sets were calculated using the same values of K_2. Thermodynamic functions for the solubility product constant behavior of silver sulfate from 0 to 200°C are presented for comparison with the previously published values.

3597 Complexation of Eu(III) by methylhydroxycyclobutenedione. Yun, S.S.; Choppin, G.R. (Florida State Univ., Tallahassee). *J. Inorg. Nucl. Chem.*; **38**: No. 5, 332-333(1976).

Recently, the thermodynamic parameters of complexation (ΔG, ΔH, ΔS) of trivalent lanthanide cations by dihydroxycyclobutenedione (squaric acid) have been determined. The data for the squarate complexation indicated that an inner-sphere chelate was formed. Complexation of the lanthanides by mono basic hydroxyketo ligands such as tropolonate, kojate and acetylacetonate also results in chelation. Methylhydroxycyclobutenedione (MHCD) represents a similar ligand which is, however, a much stronger acid. Its complexation with Eu(III) was studied to ascertain whether its lower basicity causes it to interact differently.

3598 Ab initio SCF—MO calculations of methyllithium and related systems. Absence of covalent character in the C—Li bond. Streitwieser, A. Jr.; Williams, J.E.; Jr.; Alexandratos, S.; McKelvey, J.M. (Univ. of California, Berkeley). *J. Am. Chem. Soc.*; **98**: No. 16, 4778-4784(4 Aug 1976).

SCF calculations are reported for CH_3Li using several basis sets. The largest basis set used, split shell with d orbitals on carbon (SS + d), gives an optimized geometry of r(C—Li) = 2.021 A, r(C—H) = 1.089 A, and <HCH = 105.8°, with an energy of -47.0206 au. Electron density and projection plots as well as integrated electron populations show that the C—Li bond has essentially no shared-electron covalent character. Monomeric methyllithium is described in terms of largely ionic bonding with about 0.8 e transferred from Li to CH_3. Similar calculations are described for ethyllithium, vinyllithium, and ethynyllithium.

3599 Kinetics and mechanism of the reactions of organochromium complexes with mercury(II) and methylmercury(II) ions. Leslie, J.P. II; Espenson, H. (Ames Lab., Iowa). *J. Am. Chem. Soc.*; **98**: No. 16, 4839-4844(4 Aug 1976).

Kinetic studies have been carried out on a family of organochromium complexes of the general formula $(H_2O)_5CrR^{2+}$ for the groups R = CH_3, C_2H_5, n-C_3H_7, $CH_3C(CH_3)_2$, i-C_3H_7, CH_2Cl, CH_2Br, CF_3, and p-$CH_3C_6H_4Z$ (Z = H, CH_3, CN, CF_3, and Br). These cations react with Hg^{2+} forming RHg^+ and $Cr(H_2O)_6^{3+}$, and with CH_3Hg^+ forming CH_3HgR and $Cr(H_2O)_6^{3+}$. Reaction rates were evaluated as a function of concentration in water at 25.0°, and in a few instances in other solvents and at other temperatures. These reactions are believed to follow a bimolecular, electrophilic substitution mechanism.

3600 Peroxy isomer of nitrogen dioxide. Schaefer, H.F. III (Univ. of California , Berkeley); Bender, C.F.; Richardson, J.H. *J. Phys. Chem.*; **80**: No. 18, 2035-2037(26 Aug 1976).

Ab initio SCF calculations on the relative stability of a peroxy isomer of NO_2, compared with the normal C/sub 2v/ isomer, coupled with the experimental bond strength in the normal isomer suggest that a peroxy isomer is stable. Implications to photodetachment experiments are discussed.

3601 Theoretical calculation of strong complex formation by the HO_2 radical: $HO_2.H_2O$ and $HO_2.NH_3$. Hamilton, E.J. Jr.; Naleway, C.A. (Argonne National Lab., IL). *J. Phys. Chem.*; **80**: No. 18, 2037-2040(26 Aug 1976).

Exploratory ab initio calculations using a minimal basis set support the existence of the $HO_2.H_2O$ and $HO_2.NH_3$ complexes, as proposed earlier by experiment. For the minimum energy configurations having HO_2 as the H donor within a linear H-bond structure, electronic stabilization energies of 9.1 and 12.0 kcal/mole are calculated for $HO_2.H_2O$ and $HO_2.NH_3$, respectively, compared with 5.3 kcal/mole for $(H_2O)_2$. Values of ΔH^0 and ΔS^0 for the complex formations are estimated and found consistent with available experimental data. A plausible model is proposed to explain the reactivity of these complexes. These calculations indicate that in the troposphere a significant fraction of the HO_2 is complexed with H_2O.

ISOTOPE EFFECTS

3602 (COO—3127-11) Vapor pressure isotope effect in $^{13}CClF_3/^{12}CClF_3$ by cryogenic distillation kinetics. Wieck, H.J.; Ishida, T. (Brooklyn Coll., N.Y. (USA)). Aug 1975. 148p. Dep. NTIS $6.00.

Thesis.

The vapor pressure of $^{13}CClF_3$ relative to the vapor pressure of $^{12}CClF_3$ was measured as a function of temperature between 169° and 206°K by using a modified Bigeleisen distillation column. The transient build-up of the isotopic concentration gradient along the length of the packed column during the start-up period was monitored by taking samples from the condenser section as a function of time. The gaseous samples were completely oxidized to carbon dioxide in the presence of a platinum catalyst and a large excess of oxygen at temperatures between 1050 and 1100°C. The combustion products were purified by means of gas chromatography, and the purified carbon dioxide samples were analyzed in a Nier-type isotope-ratio mass spectrometer. The data of each distillation run were reduced in the light of Cohen's theory of the kinetics of square cascade of close-separation stages. The vapor pressure isotope effect for the carbon substitution in $CClF_3$ at temperatures between 169° and 206°K was found to be an inverse effect and to be rather insensitive to changes in temperature. The relative vapor pressure may be expressed $\ln(P'/P) = [(1.5 +- 14.1)/T^2] - [(0.159 +- 0.076)/T]$, or $\ln(P'/P) = [(0.173 +- 0.098)/T] - [(0.11 +- 0.53) \times 10^{-3}]$, where P' and P are the vapor pressures of $^{12}CClF_3$ and $^{13}CClF_3$, respectively. To the first-order, the presence of chlorine isotopes would not affect the fractionation of carbon isotopes by the distillation of $CClF_3$. (auth)

3603 (COO—3127-14) Studies of carbon—isotope fractionation. Annual progress report, December 1, 1974—November 30, 1975. Ishida, T. (Brooklyn Coll., N.Y. (USA)). 1 Dec 1975. Contract E(11-1)-3127. 133p. Dep. NTIS $6.00.

The vapor pressure isotope effect of $^{13}C/^{12}C$-substitution in $CClF_3$ was measured at temperatures between 169° and 206°K by means of cryogenic distillation. The $^{13}C/^{12}C$-vapor pressure isotope effect in CHF_3 was also studied at temperatures between 161° and 205°K by a similar method. The construction of a cryostat has progressed as scheduled. The investigation of carbon isotope exchange equilibria between carbon dioxide and various carbamates dissolved in various organic solvents has continued. The five-stage system of Taylor-Ghate design was improved to shorten the transient time. A single stage apparatus was designed, built, and tested. These systems are used to measure the equilibrium constants and various phase equilibria involved in the carbon dioxide—carbamate system. The investigation of the explicit method of total isotope effect has made progress. A satisfactory approximation was found for the classical partition function of a Morse oscillator. The method gives a reasonable result at rho identical with $^1/_2\sqrt{(u/sub e//x/sub e/)}$ greater than 1.5. The medium cluster approach was applied to isotopic methanes to investigate the effects of intermolecular distance and mutual orientations of molecules in the liquid upon vapor pressure isotope effect. It was found that all geometrical effects studied tend to vanish as the size of clusters is increased. Isotope effect in the zero-point energy shifts on condensation was calculated on the basis of London dispersion forces in liquid and a semi-empirical molecular orbital theory, and was favorably compared with experimental results. (auth)

3604 **Isotopes of water. A bibliography.** Summers, W.K.; Sittler, C.J. Ann Arbor, MI; Ann Arbor Science Publishers, Inc. (1976). 296p. $20.00.

This bibliography contains at least 2300 references to currently available literature on the isotopes of water-viz., hydrogen, deuterium, tritium, and ^{18}O and ^{18}O forms. The bulk of the references appeared before 1975. The references are presented in two parts. Part I contains those references relating to tritium. The references in this part are included under the following categories: bibliography; symposia, conferences and collections; methods for measurement; decay rate; tritium production; meteorites and moon rocks; history and state of the art; processing and handling; proposals for using; methods in hydrologic studies; hydrologic cycle; biology and ecology; nuclear facilities; and supportive techniques. References to deuterium and oxygen are included in Part II. These references are organized under the following headings: bibliography; symposia, conferences and collections; history and state of the art; proposals for using; methods for measurement; physics, chemistry and thermodynamics; water, water vapor and ice; carbon dioxide and carbon dioxide-water; biology and ecology; extraterrestrial studies; concentrations in rocks and minerals; hydrologic cycle; hydrocarbons; paleotemperatures and paleoclimatology. (BLM)

ISOTOPE EXCHANGE AND ISOTOPE SEPARATION

REFER ALSO TO CITATION(S) 3603, 3604

3605 (MIT—2793-2) **Nonequilibrium photochemical reactions induced by lasers. Quarterly progress report, October 1, 1975—December 31, 1975.** Steinfeld, J.I. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Chemistry). Jan 1976. Contract E(11-1)-2793. 3p. Dep. NTIS $3.50.

Progress is reported in the following areas of research: infrared double resonance of SF_6; laser isotope separation of boron 10; and infrared-laser-induced chemistry. (LK)

ORGANIC CHEMISTRY

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

REFER ALSO TO CITATION(S) 2377, 2465, 3585, 3598, 3599, 4009

3606 (COO—3435-29) **Magnetic resonance study of the lowest triplet state of 2-chloronaphthalene.** Grandy, D.W. (Pittsburgh Univ., Pa. (USA). Dept. of Chemistry). 1976. Contract E(11-1)-3435. 29p. Dep. NTIS $4.00.

Thesis.

Electron paramagnetic resonance spectra have been obtained for 2-chloronaphthalene in a biphenyl host single crystal at 100°K. The principal values of the D and g tensors were calculated for the lowest triplet state of 2-chloronaphthalene and found to be similar to those of naphthalene. Hyperfine structure due to protons in the 1, 4, 5 and 8 positions was observed with a magnetic field H in the plane of the X axis. Using the malonic acid radical as a model, an estimate of the spin density in the α position was calculated to be 0.225. Further experiments on 2-chloro and other 2-halonaphthalenes are suggested.

3607 (ORNL/TM—5500) **Mass spectra of N-nitroso compounds.** Rainey, W.T.; Christie, W.H.; Pritchard, C.A.; Lijinsky, W. (Oak Ridge National Lab., Tenn. (USA)). Sep 1976. Contract W-7405-eng-26. 63p. Dep. NTIS $4.50.

The low-resolution electron impact mass spectra (70 eV) of 52 N-nitroso compounds are presented. Aliphatic, aromatic, and cyclic nitrosamines are represented, as are nitrosamino acids and nitrosamides. Most of the compounds showed a molecular ion. Many of them gave a fragment ion at M-30 or M-31 and an ion of m/e 30 of variable intensity. A large number of the compounds showed an ion at M-17, corresponding to loss of OH. It is expected that almost any N-nitroso compound can be characterized and identified from its mass spectrum, and this publication, with the previously published ORNL-TM-4359, serves as a source of useful comparative spectra of a diverse list of nitrosamines.

3608 **Method and device for continuously transforming a hydroxylamine salt into another hydroxylamine salt.** Maurel, A. (to CEA, 75 - Paris (France)). French Patent 2243904/A/. 14 Sep 1973. 10p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France).

Description is given of a method and a device for continuously transforming a hydroxylamine salt into an another hydroxylamine salt. The transformation is carried out, by electro-dialysis, in at least one electrolysis cell divided into four compartments by means of three diaphragms (an ion exchanging diaphragm of the anionic type, a diaphragm of the cationic type and a diaphragm of the anionic type, in succession). Into the cell are caused to flow: (1) an aqueous solution of the initial hydroxylamine salt through the second compartment from the anode; (2) an aqueous solution, the anion of which is that of the desired hydroxylamine salt through the fourth compartment from the anode, and 3) an electrolyte aqueous solution through the first and third compartments from the anode. This can be applied to the transformation of a hydroxylamine sulfate into a hydroxylamine nitrate.

3609 **Investigation of the hydrates of amine sulfates by dielectric measurements.** McDowell, W.J.; Coleman, C.F. (Oak Ridge National Lab., TN). *J. Inorg. Nucl. Chem.*; **38**: No. 4, 871-873(1976).

The dielectric constants (epsilon) of 0.025 M (0.05N) solutions of three high-molecular-weight amine sulfates in benzene were examined as a function of water content. For 3,9-diethyltridecyl-6-amine sulfate (HDAS), distinct changes in the slope of epsilon vs water/amine sulfate were interpreted as indicating polymerized monohydrate, (HDAS.H_2O)/sub n/, and monomeric dihydrate, HDAS.$2H_2O$. There was no change of slope for tri-n-octylamine sulfate (TOAS) in the H_2O/TOAS range 0.1 to 3, which is consistent with the previously reported constant hydration of TOAS throughout this range. A small change of slope for di-n-decylamine sulfate (DDAS) suggests some formation of dihydrate, DDAS.$2H_2O$.

3610 **Dimeric structure of di-tert-butylphosphinic acid.** Druyan, M.E.; Reis, A.H. Jr.; Gebert, E.; Peterson, S.W.; Mason, G.W.; Peppard, D.F. (Argonne National Lab., IL). *J. Am. Chem. Soc.*; **98**: No. 16, 4801-4805(4 Aug 1976).

The molecular structure of di-tert-butylphosphinic acid, $[(CH_3)_3C]_2PO(OH)$, as determined by single-crystal x-ray methods, is the first observed distinct dimeric $R_2PO(OH)$ compound with two acid molecules linked through a centrosymmetric configuration. The molecule crystallizes in the monoclinic space group, $P2_1/c$ with cell parameters a = 8.973 (6) A, b = 13.130 (9) A, c = 10.539 (7) A, β = 117.95 (3)°, and Z = 4. The structure was solved and refined using 999 independent three-dimensional Mo Kα x-ray data collected with an automated diffractometer. Full-matrix least-squares refinement of 620 observations for which $F_o >$ 3 sigma (F_o) led to R/sub F/ = 0.059. The discrete dimer which was found contains strong, 2.506 (18) A, hydrogen bonds, in which the oxygen atoms of O—H—O are not related by a crystallographic symmetry element. The eight-membered, hydrogen bonded ring has 1 site symmetry and shows a small chair-conformation distortion from planarity. The P—O bond lengths are 1.521 (8) and 1.520 (6) A which indicates that the oxygen atoms are essentially equivalent. There appear to be weak C—H—O interactions which fix the methyl group orientations to give an overall eclipsed conformation.

3611 **Rate constants for some electrophilic reactions of benzyl, benzhydryl, and trityl cations in solution.** Ujdak, R.J.; Jones, R.L.; Dorfman, L.M. (Ohio State Univ., Columbus). *J. Am. Chem. Soc.*; **98**: No. 16, 4875-4879(4 Aug 1976).

Absolute rate constants have been determined by the pulse radiolysis technique for several electrophilic reactions of the benzyl, the benzhydryl, and the trityl cation in 1,2-dichloroethane solution. The rate constants for the reactions of these carbonium ions with chloride ion, with bromide ion, and with iodide ion are all very nearly the same, namely 6×10^{10} M^{-1} s^{-1} at 24°C. The values very likely represent the diffusion controlled limit for the ion combination reactions. The rate constants for the reactions with triethylamine, tri-n-propylamine, and tri-n-butylamine range from 2.0×10^9 to 7×10^8 M^{-1} s^{-1} at 24°C. With increasing phenyl substitution, the decreasing trend in the magnitude of the rate constant is consistent with the combined electronic and steric effects. With increasing size of the amine, the decrease in the value of the rate constant seems to indicate that the steric effect predominates. The values of the rate constants for reactions of benzyl and benzhydryl cation with methanol, ethanol, and 2-propanol indicate the following. The rate constant is higher for reaction with the alcohol dimer in solution than with alcohol monomer. The rate constants for reaction with alcohol monomer have values of 1×10^8 M^{-1} s^{-1} or lower.

ELECTROCHEMISTRY

REFER ALSO TO CITATION(S) 3286

3612 (COO—2802-1) **Investigation of volume effects on the stability of remotely processes S-1 photocathodes. Interim report, February 1, 1976—30 June 1976.** Lynch, T.F. (ITT Electro-Optical Products Div., Fort Wayne, Ind. (USA)). 1976. Contract E(11-1)-2808. 32p. Dep. NTIS $4.00.

It has been demonstrated that the S-1 photocathode can be remotely processed and yet maintain stability over long periods of time. Although the method of process is unique, it is well understood and will yield devices which will maintain a similarity of operation. It is suggested that the Tube and Sensor Laboratories at Fort Wayne have demonstrated some of the stability requirements necessary to make the S-1 photocathode a useful tool in the research which ERDA is pursuing.

3613 **Energies of conduction bands in dielectric liquids.** Holroyd, R. (Brookhaven National Lab., Upton, NY). pp 378-387 of In Radiation research. Biomedical, chemical, and physical perspectives. Nygaard, O.F. (ed.). New York; Academic Press, Inc. (1975).

From 5. international radiation research congress meeting; Seattle, Washington, USA (14 Jul 1974).

See CONF-740715—.

The properties of excess electrons in non-polar liquids depend on the relative energies of the trapped and conducting states. We have measured the energies of the conducting states, denoted V_0, for about twenty non-polar liquids. Two methods were used: In one the work functions of metals immersed in the liquid were measured. In the other, solutes (TMPD) were photoionized in the liquid and V_0 calculated from the wavelength at which ionization onsets occur. A wide variation in conduction state energies is observed from a high of +0.21 eV for tetradecane to a low of —0.60 eV for tetramethylsilane. In general V_0 shifts to more negative values with increasing molecular symmetry, and correlates well with electron mobility. The photoionization results indicate that V_0 decreases with increasing temperature. In mixtures V_0 is linearly dependent on mole fraction. It was found empirically for n-hexane-neopentane mixtures that $\mu = 0.34 \exp[-15.2(V_0)]$. This equation relating V_0 to the electron mobility also applies approximately to pure hydrocarbons. Thus the role of the conduction state energy in influencing electron mobilities and photoionization onsets is established and recent evidence indicates V_0 also influences the rates of electron reactions in these liquids.

3614 **Mobilities of slow electrons in low- and high-pressure gases and liquids.** Christophorou, L.G. (Oak Ridge National Lab., TN). pp 397-403 of In Radiation research. Biomedical, chemical, and physical perspectives. Nygaard, O.F. (ed.). New York; Academic Press, Inc. (1975).

From 5. international radiation research congress meeting; Seattle, Washington, USA (14 Jul 1974).

See CONF-740715—.

Mobilities of slow (thermal and epithermal) electrons in low- (less than or approximately 500 Torr) and high-(approximately 500 to approximately 34,111 Torr) pressure gases are discussed and are related to the molecular structure and to the mobilities of thermal electrons in liquid media.

PHOTOCHEMISTRY

REFER ALSO TO CITATION(S) 2558, 3605, 3700

3615 (COO—3416-27) **Photoinitiated decomposition of monosilane.** Austin, E.R.; Lampe, F.W. (Pennsylvania State Univ., University Park (USA)). 1976. Contract E(11-1)-3416. 4p. (CONF-760620—2). Dep. NTIS $3.50.

From 12. informal conference on photochemistry; Gaithersburg, Maryland, United States of America (USA) (28 Jun 1976).

A mass-spectrometric study of the hydrogen-atom initiated decomposition of monosilane was made. Silyl radicals were generated by mercury photosensitization of hydrogen-monosilane mixtures which consisted of about 95 percent hydrogen. Under these conditions more than 94 percent of the $Hg(^3P_1)$ atoms that are quenched by collision react with monosilane to form silyl radicals. The further reactions of the silyl radicals are being studied. (LK)

3616 **Electron spin resonance study of N_1-substituted thymine π-cation radicals.** Sevilla, M.D. (Oakland Univ., Rochester, MI). *J. Phys. Chem.*; **80**: No. 17, 1898-1901(12 Aug 1976).

π-cation radicals produced by photoionization of thymidine 5'-monophosphate, thymidine, 1-methylthymine, 1-ethylthymine, and thymine in basic 8 M $NaClO_4$—D_2O glasses at 77 K were investigated by ESR spectroscopy. Analysis of the spectrum of each N_1-substituted thymine shows coupling to the 5-methyl group (21 G), to the nitrogen at position 1 (A/sub parallel/ = 13 G, A/sub perpendicular/ less than 4 G with g/sub perpendicular/ - g/sub parallel/ = 0.002), and to β protons on substituents at N_1. Analyses were confirmed by computer simulations. The "experimental" spin density distribution was calculated and compared to McLachlan MO predictions. Parameters of the interaction of the 1 position β protons were determined ($rho\pi = 0.21$, $B_2 = 79$) and used to evaluate the conformations of the N_1 substituent groups. Results are compared to previous results in aqueous glasses and single crystals.

RADIATION CHEMISTRY

REFER ALSO TO CITATION(S) 2470, 3611, 3637

3617 **Optical absorption spectrum of the solvated electron in polar liquids and in binary solutions.** Dorfman, L.M.; Gavlas, J.F. (Ohio Stat Univ., Columbus). pp 326-332 of In Radiation research. Biomedical, chemical, and physical perspectives. Nygaard, O.F. (ed.). New York; Academic Press, Inc. (1975).

From 5. international radiation research congress meeting; Seattle, Washington, USA (14 Jul 1974).

See CONF-740715—.

Optical absorption spectra are now known for a considerable variety of compounds ranging from strongly polar to weakly polar liquids in which lamda max may fall in the region 500 nm to 2300 nm. These systems include alcohols, amines and amides (current results), ethers and one hydroxy ether. The results will be discussed with reference to the dependence of spectrum upon the type of compound and upon the dielectric properties of the liquid. Data for binary solutions comprised of weakly polar and strongly polar components will be discussed with reference to evidence for selective interaction. With regard to the question of structure in the optical spectrum of e^-/sub sol/, our recent observations do not sustain reports that structure may be resolved. Some correlation of the broad range of experimental data with theoretical and empirical models will be presented.

3618 **Theory of optical spectra of solvated electrons.** Kestner, N.R. (Louisiana State Univ., Baton Rouge). pp 333-344 of In Radiation research. Biomedical, chemical, and physical perspectives. Nygaard, O.F. (ed.). New York; Academic Press, Inc. (1975).

From 5. international radiation research congress meeting; Seattle, Washington, USA (14 Jul 1974).

See CONF-740715—.

During the last few years better theoretical models of solvated electron have been developed. These models allow one to calculate a priori the observable properties of the trapped electron. One of the most important and most widely determined properties is the optical spectrum. In this paper we consider the predictions of the theories not only as to the band maximum but line shape and width. In addition we will review how the theories predict these will depend on the solvent, pressure, temperature, and solvent density. In all cases extensive comparisons will be made with experimental work. In addition four new areas will be explored and recent results will be presented. These concern electrons in dense polar gases, the time development of the solvated electron spectrum, solvated electrons in mixed solvents, and photoelectron emission spectra (PEE) as it relates to higher excited states. This paper will review all recent theoretical calculations and present a critical review of the present status and future developments which are anticipated. The best theories are quite successful in predicting trends, and qualitative agreement concerning band maximum. The theory is still weak in predicting line shape and line width.

3619 **Electron yields and reaction kinetics in polar liquids.** Hunt, J.W.; Lam, K.Y.; Chase, W.J. (Univ. of Toronto). pp 345-355 of In Radiation research. Biomedical, chemical, and physical perspectives. Nygaard, O.F. (ed.). New York; Academic Press, Inc. (1975).

From 5. international radiation research congress meeting; Seattle, Washington, USA (14 Jul 1974).

See CONF-740715—.

Using a stroboscopic pulse radiolysis technique, the electron yield produced by the radiation, the fast electron attachment process to solute molecules, the formation of solvated electrons e^-/sub sol/, and the e^-/sub sol/ reaction rate constants in concentrated solutions have all been studied in the time region from 20 to 350 picoseconds (ps). Some important questions have been posed by these ps studies. For example, in concentrated solutions, the electron attachment is faster than any normal diffusion process. The two most likely mechanisms are a precursor of the e^-/sub sol/ which diffuses quickly through the medium, or a long range interaction between the electron and the solute molecules. Recently, we have attacked this problem by studying the absorption spec-

trum of electrons as they orient the polar alcohol molecules. In the different wavelengths (less than 1100 nm) we have observed the absorption spectrum of electrons in the infrared, in which a shallow trap in the alcohol (a "damp" electron) relaxed to a deeper trap, the normal e-/sub sol/. The decay kinetics of the damp electrons in the presence of different electron scavengers indicate that the electron attachment process is extremely fast, less than 2 x 10^{-11} s. We have also found a close relationship between the fast electron processes, and the e^-/sub sol/ rate constants in concentrated solutions of solutes, both in water, alcohols, and water-alcohol mixtures. The initial yield of electron adducts in different solvents have been studied, and indicates that the electron yield is 5 +- .5/100 eV.

3620 Reactions rates of electrons at short times. Czapski, G. (Hebrew Univ., Israel); Peled, E. pp 356-366 of In Radiation research. Biomedical, chemical, and physical perspectives. Nygaard, O.F. (ed.). New York; Academic Press, Inc. (1975).

From 5. international radiation research congress meeting; Seattle, Washington, USA (14 Jul 1974).

See CONF-740715—.

Due to various experiments, where e/sub aq/ was observed at very short times and generally in very concentrated solutions of scavengers, it was suggested that dry electrons play a chemical role in these systems. It seems to us, that in most of these studies where the authors interpreted their results as an evidence for dry electrons, several corrections should have been made. If in these concentrated solutions the initial formation of encounter pairs of solutes with e/sub aq/ are taken into account, this does explain in many of these studies the observed behavior of the systems without having to attribute a chemical reactivity to dry electrons in reactions with solutes. Also in those systems where this effect does not explain the entire behavior, this correction should be made.

3621 Ground state structure of trapped electrons in glassy matrices. Kevan, L. (Wayne State Univ., Detroit). pp 406-414 of In Radiation research. Biomedical, chemical, and physical perspectives. Nygaard, O.F. (ed.). New York; Academic Press, Inc. (1975).

From 5. international radiation research congress meeting; Seattle, Washington, USA (14 Jul 1974).

See CONF-740715—.

The molecular dipole arrangement around excess trapped electrons in aqueous and organic glasses has recently been deduced from a combination of types of electron magnetic resonance measurements. Trapped electrons in glassy matrices typically show only a single unresolved EPR line. However, spin flip satellite lines have now been observed at 35 GHz for electrons in 10 M NaOH glass. This allows one to determine the distance to a particular number, n, of nearest neighbor protons, but n is not uniquely determined. Comparison of these data with electron spin echo results, and with calculations based on a semicontinuum potential both indicate that n = 8 and that four oriented water dipoles surround the electron with their protons 1.75 A distant. Electron spin echo signals of trapped electrons in deuterated matrices show modulation phenomena from electron-nuclear dipolar interactions which are related to the spatial arrangement of surrounding deuterons. In 10 M NaOH glass these results have been analyzed to show that the second shell water dipoles are partially oriented toward the electron. In deuterated and partially deuterated methyltetrahydrofuran (MTHF) glasses, electron spin echo results show that the trapped electron interacts with most of the protons on the MTHF molecule and that these are most probably four MTHF molecules surrounding the electron. These results are further reinforced by their agreement with semicontinuum model calculations. The picture of the electron trapping potential being formed by orientation of surrounding molecular dipoles in response to the field of the excess electron is also supported by these structural results.

3622 Some aspects of electron dynamics in solid alkanes. Cheng, I.I.; Funabashi, K. (Univ. of Notre Dame, LA). pp 415-425 of In Radiation research. Biomedical, chemical, and physical perspectives. Nygaard, O.F. (ed.). New York; Academic Press, Inc. (1975).

From 5. international radiation research congress meeting; Seattle, Washington, USA (14 Jul 1974).

See CONF-740715—.

The excess electron mobility in 3-methylpentane (3MP) is in the range of 0.02-0.1 cm^2/v.s. for 4.2-85°K. The mobility is nearly independent of temperature below 35°K, while the activation energy is about 0.01 eV for 35°K-85°K. The magnitude of mobility and its temperature dependence are consistent with the hopping and tunneling motion of electron between trapped (or localized) states. The decay kinetics of the absorption spectrum of trapped electrons in 3MP also suggest the presence of many trapping sites, and a small mean free path of retrapping for a quasi-free electron. It is conjectured that the electron-transport in 3MP glass is the phonon-assisted hopping or tunneling and the mean free path (or the mobility) at the quasi-free state is not as large as 100 A (or 150 cm^2/v.s.). The mean free path of scattering for an excess electron at the quasi-free level in various alkane glasses can be found approximately from measurement of attenuation constants for electron beams (Chang and Berry). The relationship of these attenuation constants with V_0 (quasi-free state) will be discussed. The effect of electron-phonon coupling on the effective mass of excess electrons will also be discussed in terms of a simple model. The effective mass is a sensitive function of the ratio of the relaxation energy to the phonon energy.

3623 Deferred luminescence in organic matrices at low and very low temperatures. Cordier, P.; Kieffer, F.; Lapersonne-Meyer, C.; Rigaut, J. (Univ. de Paris Sud, Orsay, France). pp 426-435 of In Radiation research. Biomedical, chemical, and physical perspectives. Nygaard, O.F. (ed.). New York; Academic Press, Inc. (1975).

From 5. international radiation research congress meeting; Seattle, Washington, USA (14 Jul 1974).

See CONF-740715—.

The recombination of trapped electrons and cations formed by gamma-irradiation or photoionization of organic glasses containing appropriate solutes gives rise to a deferred luminescence which can be observed at the temperature of irradiation for up to several hours. In all glasses studied, at sufficiently low temperatures, this isothermal luminescence (ITL) is found to decay in accordance with a linear relationship (1) $I_0/I(t) = 1 + \alpha(t - t_0)$ which seems to hold whenever recombination occurs predominantly by a tunneling mechanism. (I_0 = luminescence intensity at time t_0 of the beginning of observation, I(t) = intensity at time t, α = a constant depending only on irradiation time and time elapsed between irradiation and observation.) By irradiating at a relatively high temperature, low enough though for the ITL decay to occur according to (1) (e.g., 77°K for methylcyclohexane), and subsequently cooling to 4°K, a decrease in luminescence intensity with temperature is observed, from which an activation energy can be deduced. This is of the order of 0.04 eV between 77° and 60°K, and practically zero from 60 down to 4°K. The effect of solute concentration is discussed.

3624 Trapped electrons and anions in rigid organic glasses at 4°K. Namiki, A.; Noda, M.; Higashimura, T. (Kyoto Univ.). pp 436-442 of In Radiation research. Biomedical, chemical, and physical perspectives. Nygaard, O.F. (ed.). New York; Academic Press, Inc. (1975).

From 5. international radiation research congress meeting; Seattle, Washington, USA (14 Jul 1974).

See CONF-740715—.

States of the trapped electrons before solvation in organic glasses are reviewed emphasizing advantages in the gamma radiolysis method at 4°K. Secondary electrons are slowed down, thermalized, and then stabilized at potential wells which exist in the glasses. These wells are formed by surrounding electric dipoles which are oriented randomly. Trapped electrons transform very rapidly to solvated electrons at low temperature. Trapped electrons can be observed successfully by gamma radiolysis at 4°K. The distribution of the trap depth, sizes of trap cavities, and the yield of the trapped electrons are discussed. The electrons are captured by scavenger molecules, forming anions. Some anions are unstable even at 77°K but they become stable at 4°K. Examples are presented and their absorption spectra are discussed.

3625 Reactions of electrons in 3-methylhexane glass. Gillis, H.A.; Klassen, N.V.; Teather, G.G. (National Research Council of Canada, Ottawa). pp 443-449 of In Radiation research. Biomedical, chemical, and physical perspectives. Nygaard, O.F. (ed.). New York; Academic Press, Inc. (1975).

From 5. international radiation research congress meeting; Seattle, Washington, USA (14 Jul 1974).

See CONF-740715—.

The growth of anion has been followed from 20 nsec to several minutes following pulse irradiation of solutions of either biphenyl or pyrene in 3-methylhexane at 76°K. Scavenging by unsolvated electrons seems to be particularly important in the pyrene solutions, whereas scavenging of solvated electrons by a tunneling mechanism seems more important for the biphenyl solutions. The kinetics of electron decay in irradiated pure 3-methylhexane at various temperatures above 76°K have been studied. Absorption has been followed at several wavelengths so that electron decay could be distinguished from the blue shift in the absorption spectrum. Our results are compared with some published treatments of the kinetics of geminate combination.

3626 Formation and decay of trapped electrons in frozen media. Moan, J. (Norsk Hydro's Inst. for Cancer Research, Oslo).

pp 450-461 of In Radiation research. Biomedical, chemical, and physical perspectives. Nygaard, O.F. (ed.). New York; Academic Press, Inc. (1975).

From 5. international radiation research congress meeting; Seattle, Washington, USA (14 Jul 1974).

See CONF-740715—.

The characteristic of electron trapping and decay in various media are described. The model of electron trapping in shallow traps seems to account for most of the experimental data such as: (1) The change in optical and ESR-spectra from 4° to 77°K, (2) the time dependence of the absorption spectra, (3) the increase in e⁻/sub t/-yield and thermoluminescence yield with irradiation temperature, (4) the decrease in optical bleaching efficiency with temperature, (5) the decrease in spontaneous recombination luminescence with temperature, and (6) the recombination of electrons with cations to form triplet states, a process which needs spin relaxation and probably cannot occur within the time scale of recombination of free ions. Several mechanisms of electron decay may be important. Electron tunneling certainly takes place, notably at 4°K. Tunneling is probably also the most important mechanism of electron scavenging below the glass transition point of the solvent. However, a decay rate which is dependent on the solvent viscosity is often observed, especially in the recombination of e⁻/sub t/ with positive ions as revealed by thermoluminescence. The trapped electrons seem to be capable of moving as an entity in the field from the positive ions. Thus thermoluminescence glow curves often show a maximum near the glass transition temperature of the solvent. Thermal release of the electrons out of the traps seems to be of small importance.

3627 Electron tunneling in rigid media. Kroh, J.; Stradowski, C. (Technical Univ., Lodz, Poland). pp 462-476 of In Radiation research. Biomedical, chemical, and physical perspectives. Nygaard, O.F. (ed.). New York; Academic Press, Inc. (1975).

From 5. international radiation research congress meeting; Seattle, Washington, USA (14 Jul 1974).

See CONF-740715—.

It has been proved that electrons trapped in frozen matrices at 77°K may decay either spontaneously or in the presence of certain electron scavengers. The transfer of electrons from their traps to the scavenger molecules can proceed via quantum-mechanical tunneling. The most important experimental facts supporting such suggestion are: time and temperature dependence of electron decay, dependence on the scavenger concentration and radius, wavelength effect ("red electrons" decay faster than the "blue" ones) and electron transfer in frozen systems as measured by pulse radiolysis. The experimental data are compared with the predictions of theoretical model for electron tunneling. The applicability of this model is discussed in terms of significance of such parameters as the trap depth (characteristic for the nature of the matrix) and the density of vibrational states in scavenger molecule (characteristic for the scavenger).

3628 Application of fast polarography in pulse radiolysis. Graetzel, M.; Bansal, K.M.; Henglein, A. (Hahn-Meitner Inst. Berlin). pp 493-510 of In Radiation research. Biomedical, chemical, and physical perspectives. Nygaard, O.F. (ed.). New York; Academic Press, Inc. (1975).

From 5. international radiation research congress meeting; Seattle, Washington, USA (14 Jul 1974).

See CONF-740715—.

The principle of this method consists in the detection of short lived intermediates formed by pulse irradiation of liquids on the basis of their redox behavior at a mercury electrode. Electrokinetic analysis of the oscillographically recorded current-time curves yields information about the rate of electron transfer from the electrode to the electroactive transient and the rate constant for the disappearance of the transient in the solution bulk. Short time polarograms, i.e., plots of the current shortly after the pulse as a function of the applied potential, have been measured for numerous radicals and may now be used for their identification. The technique has been employed to investigate the electrochemical behavior of intermediates in biological redox systems such as NADH and ascorbic acid.

3629 Catalysis of electron and electron transfer reactions in micellar and protein systems. Graetzel, M.; Cooper, M.; Thomas, J.K. (Univ.[1] of Notre Dame, IN). pp 511-523 of In Radiation research. Biomedical, chemical, and physical perspectives. Nygaard, O.F. (ed.). New York; Academic Press, Inc. (1975).

From 5. international radiation research congress meeting; Seattle, Washington, USA (14 Jul 1974).

See CONF-740715—.

The technique of pulse radiolysis, using electron irradiation, is used to investigate the reactivity of charged species with solutes in or on the cationic micelle cetyltrimethylammonium bromide CTAB. The net surface charge on the micelle and proteins is changed by the addition of salt or surfactants and the resulting change in reactivity with e⁻/sub aq/ and CO_2^- is then investigated. The lifetimes of the anions of pyrene, pyrene sulfonic acid, pyrene butyric acid and bovine serum albumin are measured. The data obtained clearly shows the catalytic effect of cationic micelles in the reactions of e⁻/sub aq/ and CO_2^-. The mechanisms of the reactions are discussed. (JSR)

3630 Picosecond reactions of electrons with biologically important molecules. Lam, K.Y.; Hunt, J.W. (Univ. of Toronto). pp 524-530 of In Radiation research. Biomedical, chemical, and physical perspectives. Nygaard, O.F. (ed.). New York; Academic Press, Inc. (1975).

From 5. international radiation research congress meeting; Seattle, Washington, USA (14 Jul 1974).

See CONF-740715—.

The picosecond pulse radiolysis system has been used to study reactions of the hydrated electron, e⁻/sub aq/, with high concentrations of scavengers. Reaction rates of many scavengers observed in the picosecond time scale are quite different from that observed in the dilute solution. Moreover, the yield of e⁻/sub aq/ are drastically reduced in the presence of many scavengers. There is a direct relationship between the reaction rate constant, k, measured in picosecond time region and the efficiency, E, of the scavenger to reduce the initial yield of e⁻/sub aq/. The hydrated proton H_3O/sub aq/⁺ is an exception to the above correlation. For many ionic dissociable compounds including many amino acids and nucleotides both the k and E vary with the pH of the solution. However, at different pH's, the same relationship still holds between the k and E values. This suggests that the e-/sub aq/ and its precursor are attacking the same sites on many of these scavengers. These results suggest that studies in dilute solutions may not have direct bearing on the radiation chemistry of a living cell.

3631 Low temperature irradiation of vitrifiable mixtures of unsaturated monomers. Kaetsu, I.; Ito, A.; Hayashi, K. (to Japan Atomic Energy Research Inst.). US Patent 3,929,602. 30 Dec 1975. Priority date 10 Dec 1971, Japan. 10p.

A specific mixture containing at least one polymerizable unsaturated monomer which is not vitrifiable by itself can advantageously be polymerized by irradiating the mixture at a temperature not higher than 100°C above glass transition temperature of the mixture with an ionizing radiation and/or a light. 12 claims, 6 drawings, figures.

3632 Influence of radiation chemical effects on x-ray structure determinations. Usanmaz, A.; Adler, G. (Brookhaven National Lab., Upton, N.Y. (USA)). *Mol. Cryst. Liq. Cryst.*; **32**: No. 1-4, 123-125(Jan 1976).

From 4. International symposium on the organic solid state; Bordeaux, France (16 Jul 1975).

Condensed paper.

3633 Pulse radiolytic studies of aqueous $Mn(ClO_4)_2$ solutions. Pick-Kaplan, M.; Rabani, J. (Hebrew Univ., Jerusalem). *J. Phys. Chem.*; **80**: No. 17, 1840-1843(12 Aug 1976).

Using $Mn(ClO_4)_2$, the reactions of Mn^{2+} with CO_2^-, e⁻/sub aq/, OH, and O_2^- were studied at pH 6.7. The following reaction rate constants were measured: $k(Mn^{2+} + CO_2^-)$ less than 2×10^8 M^{-1} s^{-1}; $k(Mn^{2+} + e^-/sub\ aq/) = (9 \pm 2) \times 10^6$ M^{-1} s^{-1} (ionic strength 0.15 to 0.5 M); $k(Mn^{2+} + OH) = (3.4 \pm 0.8) \times 10^7$ M^{-1} s^{-1}; $k(Mn^{2+} + O_2^-) = (1.1 \pm 0.2) \times 10^8$ M^{-1} s^{-1} (0.01 M formate). O_2^- radical ions react with Mn^{2+} and produce Mn^{3+} or MnO_2^+ ions. The reaction was found to be reversible, and an equilibrium constant $K = (1.5 \pm 0.6) \times 10^4$ M^{-1} was measured at pH 6.7. Mn^{2+}, however, does not catalyze the dismutation of O_2^-. The disproportionation of Mn(III) (as $MnOH^{2+}$) and the subsequent nucleation of the product MnO_2 are reported.

3634 ELDOR study of methyl radical production at 77 K in irradiated acetate powders as a function of metal cation. Mottley, C.; Kispert, L.D.; Wang, P.S. (Univ. of Alabama, Tuscaloosa). *J. Phys. Chem.*; **80**: No. 17, 1885-1891(12 Aug 1976).

Paramagnetic relaxation characteristics of the methyl radical at 77°K in irradiated powders of magnesium acetate tetrahydrate, potassium acetate, sodium acetate trihydrate, calcium acetate monohydrate, zinc acetate dihydrate, and lithium acetate dihydrate were measured by power saturation techniques and ELDOR spectroscopy. For magnesium acetate tetrahydrate the characteristic relaxation time (T/sub 1e/T/sub 2e/)/sup $^1/_2$/ for the methyl radical is relatively constant with radiation dose at low doses and decreases at higher doses. For sodium acetate trihydrate the relaxation time decreases even at low dose. ELDOR measurements of the ratio of the intermolecular relaxation time (T/sub po/) between methyl radicals to the spin—lattice relaxation time (T/sub 1e/) shows an increase from 0.05 for magnesium acetate trihydrate to

greater than 1 for sodium acetate trihydrate. In addition, the field-swept ELDOR reduction factors for the m/sub I/ = -$^3/_2$ ESR line of the methyl radical utilizing 100-kHz field modulation decreases from 73 percent in irradiated magnesium acetate tetrahydrate to 2 percent in irradiated calcium acetate monohydrate. These features suggest that the radiation produced methyl radicals are trapped in clusters in acetates at low dose forming a nonuniform spatial distribution that is dependent on the cation and decreases in the approximate order Mg^{2+} greater than K^+ greater than Na^+ greater than Ca^{2+}. No estimate of the amount of clustering in the irradiated Zn^{2+} and Li^+ salts could be made due to the long T/sub 1e/'s exhibited by the methyl radical.

3635 Pulse radiolysis and electron spin resonance studies of nitroaromatic radical anions. Optical absorption spectra, kinetics, and one-electron redox potentials. Neta, P. (Carnegie-Mellon Univ., Pittsburgh); Simic, M.G.; Hoffman, M.Z. *J. Phys. Chem.*; **80**: No. 18, 2018-2023(26 Aug 1976).

Nitrobenzoic acids, dinitrobenzenes, and di- and trinitrobenzoic acids were reduced by e^-/sub aq/ and by the CO_2^- and $(CH_3)_2C(dot)OH$ radicals in irradiated aqueous solutions. The rate constants for reduction by the latter radicals were found to be close to 10^9 M^{-1} s^{-1} in most cases, with some substituent effects noted. The radical anions produced exhibit intense (epsilon approximately 10^4 M^{-1} cm^{-1}) absorption spectra peaking around 300 nm, except for p-dinitro derivatives which are shifted to the 400-nm region. They protonate with pK/sub a/2 to 3 to produce radicals which absorb at lower wavelengths and which decay considerably more rapidly. One-electron redox potentials for the nitro compounds were determined using the electron transfer reactions between their radical anions and duroquinone and observing the kinetics of these reactions and the equilibrium concentrations of all components. The potentials were found to vary from -0.433 V for m-nitrobenzoic acid to -0.257 V for p-dinitrobenzene. The radical anions have also been observed by ESR and the assignment of hyperfine constants was usually straightforward. The nitro group nitrogen hyperfine constants were correlated with the redox potentials. The mononitro derivatives were found to follow a previous correlation of various nitroaromatic and nitroheterocyclic compounds, while the dinitro derivatives yield a similar linear correlation but with a different slope. The reason for this difference is discussed. Considerations of the present results and previous studies on intramolecular electron transfer in nitrobenzoatopentaamminecobalt(III) complexes show that the redox potential is of lesser importance in determining the rate of this transfer. The important factor appears to be the spin density on the carbon bearing the carboxyl group, which when higher provides a better channel for the electrons to be transferred from the nitro anion group to the cobalt center.

RADIOCHEMISTRY AND NUCLEAR CHEMISTRY

HOT-ATOM CHEMISTRY

3636 (COO—1713-68) **Reaction studies of hot silicon and germanium radicals. Progress report, September 1, 1975—August 30, 1976.** Gaspar, P.P. (Washington Univ., Seattle (USA)). 30 Aug 1976. Contract E(11-1)-1713. 21p. Dep. NTIS $3.50.

The experimental approach to attaining the goals of this research program is briefly outlined, and the progress made in the last year is reviewed in sections entitled: (a) Primary steps in the reactions of recoiling silicon and germanium atoms and the identification of reactive intermediates; (b) Thermally induced silylene reactions; (c) The role of ionic reactions in the chemistry of recoiling silicon atoms and other ion-molecule reaction studies.

3637 Reactions of solid benzene with accelerated CH_2^+ ions. Erwin, W.R.; Gordon, B.E.; Lemmon, R.M. (Univ. of California, Berkeley). *J. Phys. Chem.*; **80**: No. 17, 1852-1853(12 Aug 1976).

Carbene ($^{14}CH_2^+$) ions, kinetic energy 10 eV, were impinged on solid benzene at -196°C and the product yields determined. These were compared with the results obtained when bare carbon ($^{14}C^+$) ions were used. In addition, the radioactivity distribution between the ring and the methyl group of the toluene product was established. Results support the earlier suggestion that carbene is an important intermediate in the benzene-to-toluene and benzene-to-cycloheptatriene syntheses. Surprisingly, labeled benzene was found to result from irradiating benzene with the $^{14}CH_2^+$ beam.

PROPERTIES OF RADIOACTIVE MATERIALS

REFER ALSO TO CITATION(S) 2502, 3141, 3587, 3610

3638 (BNWL-tr—174) **Chemistry of technetium in aqueous solution. I. The state of tetravalent technetium in aqueous solution.** Gorski, B.; Kosh, H. Translated by B. Russell from *J. Inorg. Nucl. Chem.*; **31**: 3565-3571(1969). 8p. Dep. NTIS $3.50.

The state of tetravalent technetium in aqueous solution was studied by means of electrophoresis. The ionic mobilities of different technetium ions were determined and conclusions made on the hydrolysis of the tetravalent technetium. The hydrolysis constants were calculated.

RADIOISOTOPE PRODUCTION

3639 (DPST—76-128-2) **Savannah River Laboratory monthly report: ^{238}Pu fuel form processes.** (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). Feb 1976. Contract AT(07-2)-1. 33p. Dep. NTIS $4.00.

Characterization of $^{238}PuO_2$ samples from LASL indicate both tap density and agglomeration increase while particle size decreases with milling time. Two recent samples of H-Area B-Line feed contain large amounts of fines. The dependence of pellet density on the particle size and packing of the milled powder is similar for both Multi-Hundred Watt (MHW) and Low Cost High Performance (LCHP) pellets with theoretical densities (TD's) of 83 and 90 percent, respectively. Both insufficient milling and overmilling caused cracking in MHW pellets made from problem feed. An intermediate milling time is evidently required to control pellet microstructure and density. Construction of the Plutonium Experimental Facility is 51 percent complete. Recovery of scrap ^{238}Pu has been resumed in H-Area B-Line. 12 fig., 5 tables. (auth)

COMBUSTION CHEMISTRY

REFER ALSO TO CITATION(S) 2344

ENGINEERING

FACILITIES AND EQUIPMENT

REFER ALSO TO CITATION(S) 2991, 3033, 3126, 3155

3640 (CONF-760823—8) **Parametric studies in industrial distillation.** Tedder, D.W.; Rudd, D.F. (Wisconsin Univ., Madison (USA). Dept. of Chemical Engineering; Oak Ridge National Lab., Tenn. (USA)). 1976. Contract W-7405-Eng-26. 76p. Dep. NTIS $4.50.

From Meeting of the American Institute of Chemical Engineers; Atlantic City, New Jersey, United States of America (USA) (27 Aug 1976).

The minimum venture costs for eight distillation systems separating ternary feeds are compared. Minimum cost surfaces, plotted on feed-composition coordinates, lead to heuristics for choosing the best design, based on feed composition. The regions of optimality, defined by the surface intersections, vary with the species, but some designs are always preferred at particular feed compositions.

3641 (LBL—4499) **Studies on a pilot-scale space-charge electrostatic precipator.** Carnevali, E.R. III. (California Univ., Berkelev (USA). Lawrence Berkeley Lab.). Apr 1976. Contract W-7405-ENG-48. 100p. Dep. NTIS $5.00.

Thesis.

A space-charged precipitator differs from a conventional electrostatic precipitator in that the fields necessary to move the particles from the gas onto the collecting surfaces are provided by a cloud of charged innocuous drops, such as water, rather than by a charged electrode system. The equipment and methods used to produce a fog of charged water drops are described, and the performance of a space-charge precipitator using alumina and iron oxide particles is discussed. No results were obtained which could be used to quantitatively assess the precipitator performance. However, visual observations of the precipitator indicate that it produces substantial precipitation. Work is proceeding on developing a satisfactory method for quantitatively evaluating the precipitator performance. (LCL)

3642 (LBL—4805) **Calculation of magnetic fields for engineering devices.** Colonias, J.S. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jun 1976. Contract W-7405-ENG-48. (CONF-760619—5). Dep. NTIS $3.50.

From Joint international magnetics and magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

The methodology of magnet technology and its application to various engineering devices are discussed. Magnet technology has experienced a rigid growth in the past few years as a result of the advances made in superconductivity, numerical methods and computational techniques. Included are discussions on: (1) mathematical models for solving magnetic field problems; (2) the applicability, usefulness, and limitations of computer programs that utilize these models; (3) examples of application in various engineering disciplines; and (4) areas where further contributions are needed.

3643 (MHSMP—76-12) **Computer controlled monitor system at Pantex Plant.** Kuepper, H.D. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). Apr 1976. Contract DA-11-173-AMC-487(A). 25p. Dep. NTIS $3.50.

The monitor system now in operation in the Gas Analysis Laboratory was designed to meet the Nuclear Safety specifications of a permanent and accurate record of hourly temperature and pressure readings on all weapons undergoing thermal exposure or accelerated aging. This report is designed to give the user an insight into the monitor system and its operation without requiring extensive knowledge of computer software. A flow chart of the actual monitor program as it currently exists is included as an appendix to this report. (auth)

3644 (ORNL/TM—3535(Pt.6)) **Computer codes for office of saline water program analysis. Part VI. VTE-21: a FORTRAN code for rapid calculation or optimization of vertical tube evaporator (VTE) desalination plants.** Fort, W.G.S.; Wilson, J.V. (Oak Ridge National Lab., Tenn. (USA)). Sep 1976. Contract W-7405-eng-26. 130p. Dep. NTIS $6.00.

VTE21 is a Fortran IV program for the design and costing of a vertical tube evaporator (VTE) desalination plant. The design may be optimized if desired. The plant consists of vertical tube effects, multistage flash preheater, condenser, and brine heater and associated buildings and equipment. Operating costs and direct and indirect capital costs for plant, buildings, site and intakes are calculated. Design computations are done for each vertical tube effect, but preheater computations are based on the first and last stages and a typical middle stage; as a result the program runs rapidly but does not give stage by stage parameters. The program may be used either as part of ECON21 or as a separate program, PROC21.

3645 (ORNL/TM—5495) **Plant and equipment division laboratory services series: a ten-year building-maintenance cost history.** Keesee, H.F. (Oak Ridge National Lab., Tenn. (USA)). Sep 1976. Contract W-7405-eng-26. 131p. Dep. NTIS $6.00.

Maintaining a multifacility national laboratory in a safe, reliable condition is a complex management responsibility in terms of budgets, costs, and proper utilization of personnel and material resources. Increasing wage rates and material costs, combined with decreased budgets and aging facilities, create unusual challenges to maintenance managers. A ten-year history of building-maintenance costs, a brief description of the maintenance program, analyses of personnel requirements, cost increase indexes, unit costs, cost controls, procedures, and a brief discussion of alterations and improvements are presented.

3646 (SAND—76-0096) **WULFF: a set of computer programs for the large displacement dynamic response of three-dimensional solids.** Biffle, J.H.; Gubbels, M.H. (Sandia Labs., Albuquerque, N.Mex. (USA)). Aug 1976. Contract E(29-1)-789. 56p. Dep. NTIS $4.50.

WULFF is a set of computer programs which calculates the large displacement dynamic response of three-dimensional solids. It has become evident that the large displacement dynamic problem can be solved efficiently and accurately in two dimensions, as demonstrated by the finite element code HONDO. There are applications, however, where it is not reasonable to analyze a three-dimensional structure using a two-dimensional mathematical formulation. For the three-dimensional application, it is apparent that a special purpose code which solves only the three-dimensional problem is needed. A description is given of a complete set of computer programs designed to generate a three-dimensional finite element mesh, input boundary conditions and material descriptions, solve the problem, and then graphically display the results.

3647 (SAND—76-0135) **Wireless control system for a transmitter buried in the earth.** Caffey, T.W.H. (Sandia Labs., Albuquerque, N.Mex. (USA)). Jun 1976. Contract AT(29-1)-789. 33p. Dep. NTIS $5.00.

The design and field-testing of a system with which to turn on and off a telemetry transmitter mounted within a buried earth penetrator are described. The system is designed to operate at depths of up to 50 m in soils with a conductivity of up to 100 mS/m.

3648 (SAND—76-5157) **Development of a miniature pyrotechnic torch.** Craig, J.R. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1976. Contract E(29-1)-789. 26p. (CONF-760932—1). Dep. NTIS $4.00.

From 9. symposium on explosive and pyrotechnics; Philadelphia, Pennsylvania, United States of America (USA) (15 Sep 1976).

A miniature electrically initiated pyrotechnic torch has been developed which will provide an output capable of burning through a metal barrier and igniting a pyrotechnic-diallyl phthalate material located in close proximity. The general requirements which were used as design objectives and the design concept which evolved are described. Significant parameter studies and development tests are discussed. An alternate configuration of the basic assembly is also shown.

3649 (UCID—17241) **Structural response calculations for a reverse ballistics test of an earth penetrator.** Alves, D.F.; Goudreau, G.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Aug 1976. Contract W-7405-eng-48. 65p. Dep. NTIS $4.50.

A dynamic response calculation has been performed on a half-scale earth penetrator to be tested on a reverse ballistics test in Aug. 1976. In this test a 14 in. dia sandstone target is fired at the EP at 1800 ft/sec at normal impact. Basically two types of calculations were made. The first utilized an axisymmetric, finite element code DTVIS2 in the dynamic mode and with materials having linear elastic properties. CRT's radial and axial force histories were smoothed to eliminate grid encounter frequency and applied to the nodal points along the nose of the penetrator. Given these inputs DTVIS2 then calculated the internal dynamic response. Secondly, SAP4, a structural analysis code, is utilized to calculate axial frequencies and mode shapes of the structure. A special one dimensional display facilitates interpretation of the mode shape. DTVIS2 and SAP4 use a common mesh description. Special considerations in the calculation are the assessment of the effect of gaps and preload and the internal axial sliding of components.

3650 (Y—2056) **Analysis of fluids from numerical control machines in the Y-12 Plant.** Teeter, C.R. (Oak Ridge Y-12 Plant, Tenn. (USA)). Aug 1976. Contract W-7405-end-26. 16p. Dep. NTIS $3.50.

Numerical control machines in the Oak Ridge Y-12 Plant have frequently broken down because of hydraulic-system malfunctions. Analyses of the fluids used in the systems revealed that excessive contaminants in the oil were a contributing factor in many system failures. Particle counting and sizing, differential infrared analysis, emission spectroscopy, and atomic absorption analysis were used in addition to the routine American Society for Testing and Materials (ASTM) oil analysis methods for analyzing hydraulic fluids for contaminants.

3651 (Y/EN—61) **One-stop source for technical information.** Schulman, N.J. (Oak Ridge Y-12 Plant, Tenn. (USA)). 1976. Contract W-7405-eng-26. 13p. (CONF-760511—2). Dep. NTIS $3.50.

From 23. international communication conference; Washington, District of Columbia, United States of America (USA) (12 May 1976).

More than 6,000 instruments and systems in the Oak Ridge Y-12 Plant undergo routine recalibration at certain intervals. The work is performed by teams of instrument mechanics that perform the work at the field locations where the instruments are situated or at the laboratory if the instrument is returned. The Instrumentation Control Manual provides adequate information needed to properly check these instruments on site or in the laboratory. Published in five volumes, the Manual lists all of the instrumentation in the calibration program; the locations of the instruments, their accuracies, the procedures governing calibration techniques, and other information needed. The Manual provides specific information on location of the instruments or instrument systems; identification of the instruments or systems by function; applicable procedures governing calibration; accuracy tolerances; input and output ranges; gross error information; ranges requiring calibration; calibration period in weeks; and Relation of Standards Laboratory instrumentation to the National Bureau of Standards. Each copy of the Manual lists the procedures that govern in-place calibrations, and the procedures used in the Standards Laboratory. Administrative procedures for the operation of the Instrumentation Control Program are included. (MCW)

3652 **Optimal allocation of resources in systems.** Derman, C.; Lieberman, G.J.; Ross, S.M. (Stanford Univ., CA). pp 307-324 of In Reliability and fault tree analysis. Barlow, R.E. (ed.). Philadelphia; Society for Industrial and Applied Mathematics (1975).

From Conference on reliability and fault tree analysis; Berkeley, California, USA (3 Sep 1974).

See CONF-740906—.

In the design of a new system, or the maintenance of an old system, allocation of resources is of prime consideration. In allocating resources it is often beneficial to develop a solution that yields an optimal value of the system measure of desirability. In the context of the problems considered in this paper the resources to be allocated are components already produced (assembly problems) and money (allocation in the construction or repair of systems). The measure of desirability for system assembly will usually be maximizing the expected number of systems that perform satisfactorily and the measure in the allocation context will be maximizing the system reliability. Results are presented for these two types of general problems in both a sequential (when appropriate) and non-sequential context.

3653 Calculation of asymptotic system reliability characteristics. Ross, S.M. (Univ. of California, Berkeley). pp 331-350 of In Reliability and fault tree analysis. Barlow, R.E. (ed.). Philadelphia; Society for Industrial and Applied Mathematics (1975).

From Conference on reliability and fault tree analysis; Berkeley, California, USA (3 Sep 1974).

See CONF-740906—.

A multicomponent system is considered, in which components are statistically independent and separately maintained. The following asymptotic quantities are shown to exist (with probability 1) and are derived for general structures: (i) The limiting system failure rate; (ii) The limiting average system uptime and downtime; (iii) The limiting average number of system failures due to a specified component. These results are illustrated by application to special cases.

3654 Systems of independent Markov components and their transient behavior. Keilson, J. pp 351-364 of In Reliability and fault tree analysis. Barlow, R.E. (ed.). Philadelphia; Society for Industrial and Applied Mathematics (1975).

From Conference on reliability and fault tree analysis; Berkeley, California, USA (3 Sep 1974).

See CONF-740906—.

The transient behavior of redundant systems of independent, repairable, memoryless (two state) components is studied. Four failure times for such systems are considered, each an exit time from the set of working states for initial system conditions of interest: the failure time from the perfect state, the post-recovery exit time, the ergodic exit time, and the quasi-stationary exit time. The structure of these failure time distributions and their interrelation are discussed and asymptotic estimates and bounds for their expectations are presented. When such systems have high reliability, the failure time distributions are approximately exponential and asymptotically equivalent.

3655 First passage time distribution for a parallel exponential system with repair. Brown, M. pp 365-396 of In Reliability and fault tree analysis. Barlow, R.E. (ed.). Philadelphia; Society for Industrial and Applied Mathematics (1975).

From Conference on reliability and fault tree analysis; Berkeley, California, USA (3 Sep 1974).

See CONF-740906—.

We consider a parallel system of n independent exponential repairable components. The Laplace transform and moments for the time to first failure are obtained. We derive the asymptotic distribution of the time to first failure, as the number of components increases to infinity. We also obtain lower bounds for system reliability, which in conjunction with the minimal cut lower bound of Esary and Proschan, yields lower bounds for the reliability of general coherent systems.

3656 Measures of differences in reliability. Doksum, K.A. (Univ. of California, Berkeley). pp 427-449 of In Reliability and fault tree analysis. Barlow, R.E. (ed.). Philadelphia; Society for Industrial and Applied Mathematics (1975).

From Conference on reliability and fault tree analysis; Berkeley, California, USA (3 Sep 1974).

See CONF-740906—.

Measures of differences in reliability of two systems are considered in the scale model, location-scale model, and a nonparametric model. In each model, estimates and confidence intervals are given and some of their properties discussed.

3657 Time series analysis and forecasting of failure-rate processes. Singpurwalla, N.D. pp 483-507 of In Reliability and fault tree analysis. Barlow, R.E. (ed.). Philadelphia; Society for Industrial and Applied Mathematics (1975).

From Conference on reliability and fault tree analysis; Berkeley, California, USA (3 Sep 1974).

See CONF-740906—.

A new method for analyzing failure data is described. The method is particularly useful for analyzing data which is contaminated due to inspection, maintenance, or reporting procedures. The method is based on the notion that the estimated failure rate is the realization of a stochastic process which is referred to as the failure-rate process. In order to be able to account for contaminations of the type discussed above, the failure-rate process includes periodic and trend components. The failure-rate process is approximated by an appropriate time series model of the type suggested by Box and Jenkins. The approach is novel for reliability applications and has potential for a different direction of research in reliability theory.

3658 Stress-strength models for system reliability. Bhattacharyya, G.K.; Johnson, R.A. pp 509-532 of In Reliability and fault tree analysis. Barlow, R.E. (ed.). Philadelphia; Society for Industrial and Applied Mathematics (1975).

From Conference on reliability and fault tree analysis; Berkeley, California, USA (3 Sep 1974).

See CONF-740906—.

Modeling and statistical inference for the reliability of a system consisting of several components where the operating environment interferes with the performance of the system is examined. Specifically, the situation is considered where a k-component system functions when at least s(1 less than or equal to s less than or equal to k) of the components survive a shock of a random magnitude that comes into play. Under the "equal component" model, the strengths of the components are assumed to be independent and identically distributed random variables with c.d.f. G(x) and the common stress is a random variable having the c.d.f. F(y). The reliability of such a system is then a functional of the pair (F,G). The study includes a presentation of the uniformly minimum variance unbiased estimator of reliability under a nonparametric setting, associated large sample theory and followed by an evaluation of asymptotic relative efficiency. The model formulation is then extended to allow nonidentical strength distributions for the components and methods of estimation of reliability are also investigated in this context. Finally, another formulation is treated where each component has its own strength distribution and each is subjected to an independent stress from possibly different stress distributions. The relation to system reliability studies using binomial data is elucidated.

3659 Approach to reliability assessment. Green, A.E.; Bourne, A.J. pp 895-911 of In Reliability and fault tree analysis. Barlow, R.E. (ed.). Philadelphia; Society for Industrial and Applied Mathematics (1975).

From Conference on reliability and fault tree analysis; Berkeley, California, USA (3 Sep 1974).

See CONF-740906—.

Experience has shown that reliability assessments can play an important role in the early design and subsequent operation of technological systems where reliability is at a premium. The approaches to and techniques for such assessments, which have been outlined in the paper, have been successfully applied in variety of applications ranging from individual equipments to large and complex systems. The general approach involves the logical and systematic establishment of the purpose, performance requirements and reliability criteria of systems. This is followed by an appraisal of likely system achievment based on the understanding of different types of variational behavior. A fundamental reliability model emerges from the correlation between the appropriate Q and H functions for performance requirement and achievement. This model may cover the complete spectrum of performance behavior in all the system dimensions.

CRYOGENIC AND SUPERCONDUCTING EQUIPMENT AND DEVICES

REFER ALSO TO CITATION(S) 2567, 3362, 3454, 3462, 3552, 3738, 4302, 4310

3660 Structural safety aspect of superconducting magnets for fusion reactors. Lehner, J.R.; Reich, M.; Powell, J.R. (Brookhaven National Lab., Upton, NY). *Trans. Am. Nucl. Soc.*; **23**: 36(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

PROTECTIVE STRUCTURES AND EQUIPMENT

3661 (LA—6293-PR) Ventilation systems analysis during tornado conditions. Progress report, July—December 1975. Gregory, W.S.; Duerre, K.H.; Bennett, G.A. (Los Alamos Scientific Lab., N.Mex. (USA)). Apr 1976. Contract W-7405-Eng-36. 21p. Dep. NTIS $3.50.

A review of some existing digital simulations of fluid systems, a brief description of the proposed generalized computer

code, a description of, and results from, two solution techniques, and a sample test case ventilation system are presented. The review of some fluid system simulations covers methods and techniques for development of a more general digital solution technique than the successive substitution method used in previous analyses. The structure and organization of the computer code under development is discussed. A section dealing with the development of a user-oriented input to the code is also presented. Two solution techniques suitable for solving the simultaneous non-linear algebraic and differential equations are presented. One of the techniques is based upon a loop method and employs Newton's method for obtaining simultaneous iterative corrections for the solution. The second approach is based upon a node orientation and employs Cross' method to arrive at successive iterative corrections for the solution. Graphical results using both methods are presented. The results are essentially identical. A "test-case" ventilation system is introduced. The test-case ventilation system model was developed primarily for "debugging" the proposed generalized code. The test case is a simple yet realistic representation of the types of subsystems which could be encountered in nuclear facilities.

3662 (SAND—76-5231) **Design and analysis of the Sandia Laboratories hot cell facility safety ventilation system.** Bernard, E.A.; Burress, H.B. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1976. Contract AT(29-1)-789. 15p. (CONF-760822—15). Dep. NTIS $3.50.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

Sandia Laboratories has designed a Hot Cell Facility (HCF) to support a variety of experimental programs. This facility will provide an on site capability to conduct glove box experiments with irradiated samples having intermediate levels of radioactivity-2,000 Ci of fission products and 200 Ci of plutonium. The HCF uses a combination of existing and new construction to minimize costs and maximize usage of existing facilities. A new safety ventilation system has been designed to service the HCF. The ventilation system consists of three zones as required by the Plutonium Facilities General Design Criteria, Appendix 6301 (GDC). In conforming with this GDC, the HCF can accommodate several hundred Ci of plutonium while actual Sandia requirements are for 1—5 Ci. This dilemma is discussed and possible alternatives are suggested. The maximum credible accident for the HCF is a hypereze (liquid cutting compound) fire. A combination of experimental data and calculational procedures are used to define the fire environment, predict the impact on the ventilation system components and determine the overall system effectiveness in case of such an accident.

3663 (UCID—16949-76-1) **Enhanced filtration. Progress report, January—March 1976.** Nelson, G.O.; Richards, C.P.; Taylor, R.D.; Biermann, A.H.; Miller, H.H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 15 Jun 1976. Contract W-7405-eng-48. 28p. Dep. NTIS $4.00.

Twelve types of filter media were placed in an electric field and their efficiency was tested using a sodium chloride aerosol (aerodynamic mass-median diameter was 0.82 mu with a geometric standard deviation of 1.91). Fibrous glass and polypropylene materials show the best overall efficiency and pressure-drop characteristics.

HANDLING EQUIPMENT AND PROCEDURES

REFER ALSO TO CITATION(S) 2477, 3981

SHIPPING CONTAINERS

REFER ALSO TO CITATION(S) 2482, 3119

3664 (LA-UR—76-1701) **Critical review of Type B shipping container impact analyses: present research areas and substantiating experiments.** Counts, J.; Payne, J.B. (Los Alamos Scientific Lab., N.Mex. (USA)). 1976. Contract W-7405-ENG-36. 14p. (CONF-760813—12). Dep. NTIS $3.50.

From Symposium on the design, construction and testing of packaging for the safe transport of radioactive materials; Vienna, Austria (23 Aug 1976).

Assumptions and limitations of a one-dimensional computer code for analyzing the dynamic response of Type B shipping containers subjected to a 9.14 m drop onto a rigid horizontal target are discussed. Some predicted acceleration time-histories are shown and, where possible, compared with existing experimental records. A new and more accurate mathematical model for impacting shipping containers and planned substantiating experiments are reviewed. Other projects in the ongoing research program are briefly noted.

3665 (SAND—76-5363) **Container damage correlation with impact velocity and target hardness.** Bonzon, L.L.; Schamaun, J.T. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1976. Contract AT(29-1)-789. 16p. (CONF-760813—11). Dep. NTIS $3.50.

From Symposium on the design, construction and testing of packaging for the safe transport of radioactive materials; Vienna, Austria (23 Aug 1976).

A series of tests evaluating the survivability of several radioactive material shipping containers, when subjected to high-speed impacts, was conducted. An objective of the program is to develop both analytical and empirical models or techniques which will predict the damage to containers as a function of container type, impact velocity, impact attitude, and target hardness; these analytical and experimental techniques are described. Simple structural models were used in the analyses. The analyses proceeded from simple linear spring-mass representations of the container and target, through non-linear and finite element models. Various parametric studies were made using these techniques to derive container damage estimates based on impact velocity and target hardness. The tested containers have been evaluated with respect to structural damage, leak rate, and content losses. Based on the data from two different containers, the effect of the target, stated as impact speed resulting in approximately equivalent structural deformations, is reported.

3666 (EURFNR—1301) **Heat removal experiments on an SNR fuel element using a sodium-filled transport container.** Pruessmann, M.; Raepple, B.; Weinert, E. (Kernforschungszentrum Karlsruhe (Germany, F.R.)). Aug 1975. Translation of KFK—2174. 153p. Dep. NTIS $6.75.

Work performed under United States—Euratom Fast Reactor Exchange Program.

Among the problems associated with the introduction of fast breeder reactors is that of the handling during operations of SNR (Fast Sodium Reactor) fuel elements, and their transportation to a reprocessing plant. For example, in order to learn about the earliest possible time at which this journey can begin, it is necessary to know the maximum heat output of a fuel element, under practical operational conditions for which transportation is possible without exceeding the established limiting temperatures. If the heat transmitting material has a melting point above room temperature, it is also interesting to know the limiting heat output at which the coolant solidifies (formation of blockages). The quantity of heat that can be removed from a transport container is determined by the temperature relationships at the outer surface of the container, which, in turn, are determined by the interior temperature distribution. The results of a calculation of the temperatures arising in the interior would be inadequate, because the contribution of convective heat transfer is unknown. Experiments were therefore carried out, using an electrically heated dummy in a transport container, in order to discover the effect of natural convection in the coolant. The object of the experiments was to gather information on heat transfer within the container by measuring and displaying the temperature profiles under various operating conditions, and to deduce the removable thermal power with this arrangement.

LASERS

REFER ALSO TO CITATION(S) 2454, 3605, 4326, 4327, 4329

3667 (EUR-CEA-FC—772) **Mode study, beam characteristics of a 100mW CW 337 μm HCN waveguide.** Belland, P.; Veron, D.; Whitbourn, L.B. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Groupe de Recherches sur la Fusion Controlee; CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee). May 1975. 26p. INIS.

The first continuous submillimeter waveguide laser operating on the 337 microns HCN lines is described, and the results of the first comprehensive experimental study of its low-loss modes are presented. The laser cavity is a 5 cm diameter, 2.4 meter long, pyrex tube with plane reflectors (one of them is a metal mesh) against its ends. Eight modes were identified. Intensity distributions in the beam cross section and mode polarization were studied. The results agree with theoretical predictions for dielectric waveguide modes. The propagation of the EH_{11} mode in free space was also studied. The beam propagates as a Gaussian beam at moderate, and large distances from the mesh coupler. The maximum output power of the laser is of the order of 100 mW representing the highest output power per unit volume so far reported for a continuous HCN laser.

3668 (IPF—74-12) **Development of a hydrogen fluoride laser. Pulse width about 10 ns; for density measurements at the plasma**

focus. Schilling, P. (Stuttgart Univ. (TH) (Germany, F.R.). Inst. fuer Plasmaforschung). 1974. 56p. (In German). INIS.

32 figs.; 26 refs.

A hydrogen fluoride laser with variable pulse width (9 to 25 ns) was developed for measurements of shortlived dense plasmas. The multi-line laser with lambda approximately 2.9 μm operates without an optical pulse cutting system. Peak power of the pulses is about 400 kW. Measurements concerning dependence of FWHA, peak power, and energy yield were carried out. Combined with an amplifier of 1 m length, peak power up to 13 MW and energies up to 0.5 J are attained. With this system, time dependence of the power amplification in the amplifier was tested for various gas mixtures. Preliminary measurements with time-resolved schlieren interferometry with this system are discussed. A plasma focus device was used as test object.

3669 (ONERA-NT—216) **Flow with vibrational energy exchange, application to CO_2 electric laser.** Dahan, C. (Office National d'Etudes et de Recherches Aerospatiales (ONERA), 92 - Chatillon (France)). 1974. 80p. (In French). INIS.

The performances of a continuous wave (CO_2, N_2, He) lasers ionized by an electron beam are calculated. Several types of phenomena are considered: energy exchange processes between molecules of laser medium, electron molecular excitation processes, and aerodynamic phenomena. The energy exchanges accompanying the laser effect generate important quantities of heat which have to be evacuated by the flow. After a survey of the fundamental assumptions on molecular phenomena, a computer code was developed for following, along the flow, the evolution of the thermodynamic parameters (pressure, temperature), of the laser gain, and of the electrical properties (electron density and temperature). A model giving the energy distribution of the electrons in the laser medium was established.

3670 (SAND—76-0139) **Neutronics analysis for a subcritical nuclear laser driver excited by a fast pulse reactor.** Schmidt, T.R.; McArthur, D.A. (Sandia Labs., Albuquerque, N.Mex. (USA)). Apr 1976. Contract AT(29-1)-789. 30p. Dep. NTIS $9.00.

Recent measurements at Sandia Laboratories have demonstrated that a laser gas excited solely by fission products can be made to lase. This paper explores the concept of a subcritical nuclear driven laser (NDL) system excited by a fast pulse reactor of the Godiva type. A neutronics analysis, presented for a NDL system used with the SPR II/SPR III pulse reactors, indicates that megajoules of energy can be deposited in the laser gas in a time interval on the order of 150 to 200 microseconds. The data included here would also be useful in the design of NDL experiments using the SPR reactors or serve as a parametric study for reactor excited NDL's.

3671 (UCRL—13647-2) **Explosion energies of 2.7 cm bore flashtubes. Second report.** Benson, A.P. (EG and G, Inc., Salem, Mass. (USA). Electro Optics Div.). 3 Jun 1974. Contract 3043705. 27p. Dep. NTIS $4.00.

For Univ. of California, Livermore.

Measurements performed on large bore flashtubes with different wall thicknesses and xenon at the same pressure are discussed. The goal is to determine what effects the wall thickness has on blow up energy and the blow up constant A. In addition, a simmer mode operation was tried to see if it had any effect on the explosion energy. This work is a follow up on the work performed earlier on lamps with different fill pressures. In the course of the work, fourteen lamps of three different wall thicknesses were exploded using a pulse width of 3 $\sqrt{LC}$ = 500 usec. Care was taken to measure each lamp before and after explosion for O. D. and wall thicknesses, the circuit parameters including loss factors, and the procedures of testing.

3672 (UCRL—13649) **Effect of quartz surface treatment on the blow-up of xenon flashtubes. Technical report number B-4435.** Benson, A.P.; Newell, P.B. (EG and G, Inc., Salem, Mass. (USA). Electro Optics Div.). Jun 1975. Contract 5202915. 31p. Dep. NTIS $3.50.

For Univ. of California, Livermore.

The effects of selected quartz surface treatments, such as etching and fire polishing, on the explosion energy of flashtubes were determined. In addition, selected flashtubes were life tested and then exploded to determine the longevity of any beneficial treatments found. The test results showed that no improvement in explosion energy can be expected as a result of the treatments. In two cases, however, the explosion energy was actually improved after the flashtubes experienced 10,000 shots at low energy. Samples of clear fused quartz were etched. The effect of this etching was studied by means of a scanning electron microscope and was used to generate a procedure for etching lamps for the life test and blow-up work. Test lamps were fabricated under different quartz surface treatments and then work was done on the life testing and blow-up of these lamps. This work was done to measure the effects of extensive life on the explosion energy under the different quartz surface treatments. The hydrostatic rupture of lamps by means of internal oil pressure was studied to determine the actual strength of two different types of quartz: standard CFQ and M380 quartz. No difference in rupture strength was found.

3673 (UCRL—13686) **Short wavelength chemical laser study. Final report.** Wang, J.H.S. (Hughes Aircraft Co., Culver City, Calif. (USA). Laser Div.). May 1976. Contract 8763905. 47p. Dep. NTIS $4.00.

For Univ. of California, Livermore.

An attempt to measure the lifetime of CS($a^3\pi$) state and its related quenching rates has been performed using the flashlamp excitation technique. No emission in addition to the background signal was detected. A detailed calibration of the experimental apparatus indicates that the radiative lifetime of the CS($a^3\pi$) state is most likely longer than 1000 μsec. This long lifetime is beyond the range of interest for the possible development in the short wavelength chemical laser.

3674 (UCRL—51951) **Polishing and characterizing diamond-turned optics.** Saito, T.T. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 3 Nov 1975. Contract W-7405-ENG-48. 39p. Dep. NTIS $4.00.

Diamond-turned, flat optical mirrors were characterized for reflectivity, roughness, slope-height distribution, and autocorrelation length. Reflectivity was outstanding and the light scattering was very low. Toroidal resonator optics were diamond-turned and evaluated, and should be adequate for 10.6 μm use. Details of the toroidal analysis and polishing are included. Diamond-turned mirrors were polished with conventional and ion polishing techniques: initial results are promising, but further development is required.

3675 (UCRL—77246) **Concentric heat pipe cavity for e-beam excited lasers.** Haller, F.B.; Hessel, M.M.; Neef, W.; Lai, W.; Lohr, H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1976. Contract W-7405-ENG-48. 7p. (CONF-751125—144). Dep. NTIS $3.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

A concentric heat pipe oven for metal vapor noble gas mixtures was designed and constructed as a high power laser cavity for laser fusion applications. A 1-MeV 100 kA 50 ns e-beam was injected into the oven through a 5 mil stainless steel foil window. Details of the construction and design considerations of the heat pipe oven, foil window and safety features are given.

3676 **Visible cw and long-pulse lasing in S II and S III.** Dessert, R.A. Wright-Patterson AFB, OH; Air Force Inst. of Tech. (1974). 257p. University Microfilms Order No. 76-6503.

Thesis (Ph. D.).

The sulfur ion laser is investigated in three slotted-hollow cathode and two positive column laser (PCL) configurations. Laser action was achieved only in the PCL configurations. In the 1.76-mm dia x 500-mm long laser, true cw operation was achieved on 9 transitions in S II for periods up to 46 s. The lack of adequate thermal dissipation from the PCL capillary precluded operation for longer periods. cw operations were achieved on 5321-, 5346-, 5429-, 5433-, 5454-, 5474-, 5510-, 5640-, and 5647-A at a discharge current of 1 A using Ne buffer gas at 5.6 torr flowing over sulfur crystals at 97°C at 5.6 torr.cc.sec^{-1}. (Diss. Abstr. Int., B)

3677 **Optical design problems in laser systems. Proceedings of the Society of Photo-Optical Instrumentation Engineers, San Diego, California, August 21—22, 1975.** Sooy, W.R. (ed.). Palos Verdes Estates, CA; Society of Photo-Optical Instrumentation Engineers (1975). 192p. (CONF-750887—).

From SPIE national seminar on optical design problems in laser systems; San Diego, California, United States of America (USA) (21 Aug 1975).

Twenty-three papers were presented at the conference. A separate abstract was prepared for each of fifteen papers. (MHR)

3678 **Lasers and optics: an overview.** Sooy, W.R. (Science Applications, Inc., McLean, VA). pp 3-9 of In Optical design problems in laser systems. Sooy, W.R. (ed.). Palos Verdes Estates; Society of Photo-Optical Instrumentation Engineers (1975).

From SPIE national seminar on optical design problems in laser systems; San Diego, California, United States of America (USA) (21 Aug 1975).

See CONF-750887—.

A descriptive survey of the special optical problems which arise in the design and use of lasers is presented. The optical problems, and some of the solutions, related to achieving and preserving spatial and temporal coherence, working with high power beams, and diagnosing laser characteristics are treated.

3679 Optical design problems in dye lasers. Mack, M.E. (Avco Everett Research Lab., Inc., Everett, MA). pp 35-37 of In Optical design problems in laser systems. Sooy, W.R. (ed.). Palos Verdes Estates; Society of Photo-Optical Instrumentation Engineers (1975).

From SPIE national seminar on optical design problems in laser systems; San Diego, California, United States of America (USA) (21 Aug 1975).

See CONF-750887—.

For many applications present dye lasers must be improved with regard to output power, spectral brightness and beam quality. This development is hampered by significant optical problems, particularly thermal distortion effects. These problems can be minimized but not eliminated so that some compromises in laser performance are necessary.

3680 Total internal reflection face pumped laser: concept and design consideration. Hulme, G.J. (General Electric Co., Binghamton, NY); Jones, W.B. pp 38-44 of In Optical design problems in laser systems. Sooy, W.R. (ed.). Palos Verdes Estates; Society of Photo-Optical Instrumentation Engineers (1975).

From SPIE national seminar on optical design problems in laser systems; San Diego, California, United States of America (USA) (21 Aug 1975).

See CONF-750887—.

The Total Internal Reflection - Face Pumped Laser (TIR-FPL) has demonstrated the capability of producing high brightness beams in a repetitively pulsed manner. Reported herein are the recent performance results of several laboratory models which utilize both Nd:Glass and Nd:YAG. With a Nd:Glass slab operating in a simple Q-switched oscillator cavity, performance has been demonstrated with a near diffraction limited beam of 0.5 joules/pulse, 10 pulses/second. With the same laser operating as an amplifier for a Q-switched Nd:YAG TIR-FPL oscillator, performance has been demonstrated with an output beam of 1.5 joules/pulse at 10 pulses/second. An Nd:Glass laser with a large slab has been operated with a Q-switched output beam of 9.5 joules/pulse at 3.0 pulses/second and 25 joules/pulse at 2.5 pulses/second. A description of a preliminary hardware design for a high brightness FPL-TIR designator system operating with an output beam of 5.0 joules/pulse, 10 pulses/second is presented. Optical design considerations unique to the FPL are emphasized.

3681 High energy glass lasers. Glaze, J.A. (Lawrence Livermore Lab., CA). pp 45-54 of In Optical design problems in laser systems. Sooy, W.R. (ed.). Palos Verdes Estates; Society of Photo-Optical Instrumentation Engineers (1975).

From SPIE national seminar on optical design problems in laser systems; San Diego, California, United States of America (USA) (21 Aug 1975).

See CONF-750887—.

To investigate intense pulse propagation phenomena, as well as problems in laser and system design, a prototype single-chain laser called CYCLOPS was built and operated. This laser employs a 20-cm clear aperture disk amplifier in its final stage and produces a terawatt pulse whose brightness exceeds 10^{18} watts/cm^2-ster. The CYCLOPS system is summarized and aspects of nonlinear propagation phenomena that are currently being addressed are discussed.

3682 Electrically excited CO_2 lasers. Quelle, F.W. (Office of Naval Research, Boston). pp 55-63 of In Optical design problems in laser systems. Sooy, W.R. (ed.). Palos Verdes Estates; Society of Photo-Optical Instrumentation Engineers (1975).

From SPIE national seminar on optical design problems in laser systems; San Diego, California, United States of America (USA) (21 Aug 1975).

See CONF-750887—.

The development of high power electrically excited CO_2 gas lasers is traced from their inception to their rather sophisticated present day form. Particular attention is paid to the optical homogeneity problems which limit the degree of diffraction limitness attainable with a given laser.

3683 CO lasers: design considerations. Mann, M.M. (Northrop Research and Tech. Center, Hawthorne, CA). pp 64-73 of In Optical design problems in laser systems. Sooy, W.R. (ed.). Palos Verdes Estates; Society of Photo-Optical Instrumentation Engineers (1975).

From SPIE national seminar on optical design problems in laser systems; San Diego, California, United States of America (USA) (21 Aug 1975).

See CONF-750887—.

CO lasers are attracting increasing attention as the result of demonstrated advantages in power conversion and volumetric efficiency, and projections of favorable atmospheric propagation characteristics. A high energy pulsed electric discharge laser (EDL) has demonstrated efficiencies in excess of 60 percent, and a small (approximately 1 liter) supersonic CO EDL has produced over 100 kW under quasi-cw conditions (approximately 2 milliseconds). Further improvements in performance are anticipated for optimized devices. Balanced against these advantages are a number of technological problems which must be addressed before practical devices can be realized. Of particular significance are the problems associated with obtaining diffraction limited performance. Beam quality may be degraded by many factors, e.g., flow induced medium inhomogeneities, non-uniform heat addition, boundary layer effects, turbulent fluctuations, and component limitations. The effects are particularly pronounced for CO EDL's because of the high density of the active medium, and devices must be designed to minimize or compensate for these disturbances. The status of CO EDL technology and the considerations which must be taken into account in the design of this class of device are reviewed briefly.

3684 Promise and limitations of 10.6μ waveguide laser power amplifiers. Laakmann, K.D. (Hughes Aircraft Co., Culver City, CA). pp 74-82 of In Optical design problems in laser systems. Sooy, W.R. (ed.). Palos Verdes Estates; Society of Photo-Optical Instrumentation Engineers (1975).

From SPIE national seminar on optical design problems in laser systems; San Diego, California, United States of America (USA) (21 Aug 1975).

See CONF-750887—.

A study was performed to determine the performance of a wideband chirp-driven waveguide amplifier. Included in the study are the closed-form solutions of the rate equations with a chirped input, the calculation of the frequency errors generated by dispersion and the necessary waveform needed to overcome dispersion and thirdly the effects of a saturation and a nonuniform susceptibility profile across the aperture of the waveguide on the mode quality. The topics discussed are: (1) the absence of saturation-induced power broadening of the amplifier bandwidth in fast chirped radar applications; (2) the excellent mode discrimination properties in waveguide devices, particularly when compared to the more conventional free-space device; and (3) the mechanisms that cause degradation in performance of waveguide amplifiers in laser radar applications.

3685 Ubiquitous collimator: a short dissertation. Stitch, M.L. (Exxon Nuclear Co., Richland, WA). pp 85-89 of In Optical design problems in laser systems. Sooy, W.R. (ed.). Palos Verdes Estates; Society of Photo-Optical Instrumentation Engineers (1975).

From SPIE national seminar on optical design problems in laser systems; San Diego, California, United States of America (USA) (21 Aug 1975).

See CONF-750887—.

If one defines an optical component as an assembly of two or more optical elements, then the collimating telescope is probably the most used optical component in laser systems. Some concepts are reviewed which indicate why this might be so.

3686 Laser power and energy measurements. Boyne, H.S. (National Bureau of Standards, Boulder, CO). pp 90-94 of In Optical design problems in laser systems. Sooy, W.R. (ed.). Palos Verdes Estates; Society of Photo-Optical Instrumentation Engineers (1975).

From SPIE national seminar on optical design problems in laser systems; San Diego, California, United States of America (USA) (21 Aug 1975).

See CONF-750887—.

Laser source and detector characterization necessary for laser systems design is reviewed. Power, energy and temporal development of sources are discussed. Also, the spatial response of detectors is addressed.

3687 High power optics. Monsler, M. (Science Applicatons, Inc., Bedford, MA). pp 95-106 of In Optical design problems in laser systems. Sooy, W.R. (ed.). Palos Verdes Estates; Society of Photo-Optical Instrumentation Engineers (1975).

From SPIE national seminar on optical design problems in laser systems; San Diego, California, United States of America (USA) (21 Aug 1975).

See CONF-750887—.

The design of optical components for high average power lasers requires some additional and unique considerations not present in low power systems. Most common components simply cannot survive in the hostile environment of a high power laser beam. The most successful approaches are those which most constructively deal with the problem of the absorption of laser radiation and the removal of waste heat, while staying within an allowable beam distortion budget. A discussion of the problems and promise of four high power components, solid windows,

aerodynamic windows, high reflectance mirror coatings, and pulsed damage resistant mirrors, is given. The state of the art performance of these optical elements is discussed. Finally, some crucial issues, which must be resolved if applications of high average power lasers are ever to become routine, are enumerated.

3688 Light scattering and absorption in infrared laser mirrors. Decker, D.L.; Bennett, H.E.; Bennett, J.M. (Michelson Labs., China Lake, CA). pp 107-117 of In Optical design problems in laser systems. Sooy, W.R. (ed.). Palos Verdes Estates; Society of Photo-Optical Instrumentation Engineers (1975).

From SPIE national seminar on optical design problems in laser systems; San Diego, California, United States of America (USA) (21 Aug 1975).

See CONF-750887—.

The demands on the performance of mirrors used in high energy laser applications may be summarized as follows: (1) excellent optical figure even under high thermal load, (2) high catastrophic damage threshold, and (3) low scattering level. Light scattering, particularly backscattering, is important, and can result in cavity depumping or damage to components in the cavity. Scattering is a consequence of microirregularities, localized imperfections, and contamination at the mirror surface. For many surfaces total integrated scatter (TIS) for visible wavelengths follows a 1/lambda^2 dependence, as predicted theoretically for distributed microirregularities. However, at infrared wavelengths, TIS levels often are much larger than predicted by this theory. Evidence that this additional scatter is a consequence of dust and other localized imperfections rather than distributed microirregularities will be presented. Comparison of TIS levels and angular scattering distribution measurements for several surfaces with the results that a newly derived theory using directly measured FECO surface statistical information will be made. Low absorption under thermal load is also a very desirable characteristic of laser mirrors, both because mirror heating causes loss of optical figure and because the damage threshold of the mirror surface is related to its reflectance, R, as a function of temperature, T. Typically, R approximately 1 so that even large percentage changes in absorption with increasing temperature result in very small changes in dR/dT. However a new instrument has been designed to measure these small changes and measurements on a number of mirror coatings made with a precision of better than 1 x 10^{-4} will be presented and interpreted.

3689 Energy extraction optimization in lasers. Dishington, R.H. (Hughes Aircraft Co., Culver City, CA). pp 135-147 of In Optical design problems in laser systems. Sooy, W.R. (ed.). Palos Verdes Estates; Society of Photo-Optical Instrumentation Engineers (1975).

From SPIE national seminar on optical design problems in laser systems; San Diego, California, United States of America (USA) (21 Aug 1975).

See CONF-750887—.

A simple process for optimizing laser efficiency is presented. While the basic ideas are generally applicable, most of the graphs and equations apply specifically to four level, solid state, Q-switched devices. Efficiency, in the form of a conservation of energy equation, connects output to input through a series of factors. These are related to the system parameters and optimization curves are given. The conservation of energy equation separates naturally into two parts, the pumping and lasing phases. The latter is considered first, in terms of rate equation solutions presented on a P-N diagram. Energy stored in the rod, fluorescence and output energy are related to mirror reflectivity R, resonator losses, and rod constants. Q-switched pulse length and allowed power densities in the resonator are related to the optimum R. Next, pumping efficiency is considered. After a brief discussion of pump head efficiency, the relationships between lamp output and circuit and lamp parameters are given. Based on recently published work on arc expansion dynamics, the energy delivered, charge, voltage and spectral factors are discussed. Finally, a curve of the pumping fluorescence factor is found and the overall optimization procedure is summarized.

3690 Optical design problems in industrial solid state lasers. Koechner, W. (Hadron, Inc., Santa Monica, CA). pp 148-157 of In Optical design problems in laser systems. Sooy, W.R. (ed.). Palos Verdes Estates; Society of Photo-Optical Instrumentation Engineers (1975).

From SPIE national seminar on optical design problems in laser systems; San Diego, California, United States of America (USA) (21 Aug 1975).

See CONF-750887—.

In industrial applications of solid state lasers, such as materials processing, it is necessary to surround the laser with auxiliary optical devices. Discussed are the optical peripherals, which include appropriate optics for shaping, directing and focusing the laser beam, optics for viewing of the worksite, components to protect optics from contamination due to ejected material, beam monitors, radiation enclosures and safety shields necessary to provide for the safety of operating personnel and passersby.

3691 Infrared radiation detector for laser diagnostics. Thompson, J.E. (Northrop Research and Tech. Center, Hawthorne, CA). pp 169-174 of In Optical design problems in laser systems. Sooy, W.R. (ed.). Palos Verdes Estates; Society of Photo-Optical Instrumentation Engineers (1975).

From SPIE national seminar on optical design problems in laser systems; San Diego, California, United States of America (USA) (21 Aug 1975).

See CONF-750887—.

A liquid biased, liquid crystal, infrared radiation detector has been devised for the purpose of determining the time integrated output spectrum and power spatial distribution of infrared radiation. The device has been specifically used to measure the spectrum and spatial power distribution of the output of a quasi-cw carbon monoxide gas laser. The detector recording medium is composed of thin mylar coated with temperature sensitive, encapsulated, cholesteric, liquid crystals and energy absorbing black paint. A uniform spatial color distribution of the liquid crystals is established and maintained by immersion in a controlled temperature liquid bath. The resulting uniform color distribution is modified, at various spatial points, by the addition of laser energy obtained either indirectly from the laser output coupler to yield the spatial dependence of the near or far field laser output or from a spectrometer output to yield the spectrum of the laser output. The addition of less than 15 mJ/cm^2 of incident energy is adequate to modify the color distribution. The uniformity and precise control of the liquid crystal temperature and hence color, by the use of a liquid bath, makes it possible to compare colors, and hence laser output powers, at various spatial points. This permits the mapping of the laser near field output spatial distribution and the distribution of the laser spectrum with greater sensitivity than has been possible with more conventional techniques. Results showing the near field energy distribution and output spectrum of a supersonic flow, electric discharge CO laser obtained using the detection technique will be presented.

3692 Recent development in dye lasers. Schaefer, F.P. (Max-Planch-Institut fuer Biophysikalische Chemie, Goettingen, Ger.). pp 39-45 of In Laser spectroscopy. Haroche, S.; Pebay-Peyroula, J.C.; Haensch, T.W.; Harris, S.E. (eds.). New York; Springer-Verlag (1975).

From Conference on laser spectroscopy; Megeve, France (23 Jun 1975).

See CONF-7506103—.

New dyes were found and new experimental findings allow a better understanding of the photodegradation process in dye lasers. Vapor phase dye lasers were operated. Progress was made in new resonator configurations and tuning methods and higher average power and higher reliability. UV- and IR-wavelength regions that can be generated with dye lasers by nonlinear methods were extended and the efficiencies of the conversion processes increased. (MHR)

3693 Tunable vuv lasers and picosecond pulses. Bradley, D.J. (Imperial Coll. of Science and Tech., London). pp 55-65 of In Laser spectroscopy. Haroche, S.; Pebay-Peyroula, J.C.; Haensch, T.W.; Harris, S.E. (eds.). New York; Springer-Verlag (1975).

From Conference on laser spectroscopy; Megeve, France (23 Jun 1975).

See CONF-7506103—.

Recent developments in coaxial electron-beam pumped vuv lasers are reported. The production of tunable-frequency subpicosecond pulses by transient stimulated Raman scattering and the extension of electron-optical chronoscopy to subpicosecond time resolution and to xuv and x-ray wavelengths are described. (MHR)

3694 Excimer and energy transfer lasers. Lorents, D.C.; Huestis, D.L. (Stanford Research Inst., CA). pp 100-111 of In Laser spectroscopy. Haroche, S.; Pebay-Peyroula, J.C.; Haensch, T.W.; Harris, S.E. (eds.). New York; Springer-Verlag (1975).

From Conference on laser spectroscopy; Megeve, France (23 Jun 1975).

See CONF-7506103—.

The spectral and temporal behavior of XeO emissions from high-density Xe—O_2 mixtures excited by a short pulse of electrons from a Febetron 706 were studied. The energy level diagram of Ar_2 is shown. (MHR)

3695 Recent advances in tunable infrared lasers. Mooradian, A. (Massachusetts Inst. of Tech., Lexington). pp 198-206 of In Laser spectroscopy. Haroche, S.; Pebay-Peyroula, J.C.; Haensch, T.W.; Harris, S.E. (eds.). New York; Springer-Verlag (1975).

From Conference on laser spectroscopy; Megeve, France (23 Jun 1975).

See CONF-7506103—.

Some recent results in understanding and developing tunable infrared lasers for use in high resolution spectroscopy and photochemistry are described. Work done at M.I.T. Lincoln Laboratory on spin-flip Raman lasers, optically pumped semiconductor lasers, nonlinear frequency mixing in crystals, and optically pumped gas lasers is covered. (MHR)

3696 Broadly tunable ir source. Byer, R.L.; Herbst, R.L.; Fleming, R.N. (Stanford Univ., CA). pp 207-226 of In Laser spectroscopy. Haroche, S.; Pebay-Peyroula, J.C.; Haensch, T.W.; Harris, S.E. (eds.). New York; Springer-Verlag (1975).

From Conference on laser spectroscopy; Megeve, France (23 Jun 1975).

See CONF-7506103—.

A widely tunable coherent source based on a Nd: YAG pumped $LiNbO_3$ oscillator is described. The $LiNbO_3$ oscillator's basic tuning range of 1.4 μm to 4.2 μm is extended to 2600 A by frequency doubling and to 25 μm by frequency mixing. (MHR)

3697 Broadly tunable lasers using color centers. Mollenauer, L.F. (Bell Telephone Labs., Holmdel, NJ). pp 227-238 of In Laser spectroscopy. Haroche, S.; Pebay-Peyroula, J.C.; Haensch, T.W.; Harris, S.E. (eds.). New York; Springer-Verlag (1975).

From Conference on laser spectroscopy; Megeve, France (23 Jun 1975).

See CONF-7506103—.

Certain color centers in the alkali halides have made possible broadly tunable, optically pumped, cw, "dye-like" lasers for the near infrared. The luminescence bands of a few of the centers suitable for laser action are shown. Since the complexities introduced by two electrons make the ultimate suitability of the F_2 hard to predict, this work concentrates on the two simpler, single-electron systems, the F/sub A/(II) and the F_2^+. The following topics are covered: optical pumping systems and gain, the construction and performance of a color-center laser, preparation of color centers, and a distributed feedback laser. (MHR)

3698 Oxygen auroral transition laser system excited by collisional and photolytic energy transfer. Murray, J.R.; Powell, H.T.; Rhodes, C.K. (Univ. of California, Livermore). pp 239-247 of In Laser spectroscopy. Haroche, S.; Pebay-Peyroula, J.C.; Haensch, T.W.; Harris, S.E. (eds.). New York; Springer-Verlag (1975).

From Conference on laser spectroscopy; Megeve, France (23 Jun 1975).

See CONF-7506103—.

The properties of laser media involving the auroral transition of atomic oxygen and analogous systems are examined. A discussion of the atomic properties, collisional mechanisms, excitation processes, and collisionally induced radiative phenomena is given. It was found that crossing phenomena play a particularly important role in governing the dynamics of the medium. (MHR)

3699 Synchronous mode-locked dye lasers for picosecond spectroscopy and nonlinear mixing. Goldberg, L.S.; Moore, C.A. (Naval Research Lab., Washington, DC). pp 248-258 of In Laser spectroscopy. Haroche, S.; Pebay-Peyroula, J.C.; Haensch, T.W.; Harris, S.E. (eds.). New York; Springer-Verlag (1975).

From Conference on laser spectroscopy; Megeve, France (23 Jun 1975).

See CONF-7506103—.

Studies and applications are described of a synchronous mode-locked dye laser which is pumped by intense 25 ps pulses from a passively mode-locked, frequency-doubled Nd:YAG laser. The performance of the dye laser replicates the main features of the Nd:YAG pump. Through use of Fabry—Perot tuning elements, efficient generation of short pulses of transform-limited bandwidth were obtained which can be tuned over a broad range in several laser dyes. (MHR)

3700 Isotopic enrichment in laser photochemistry. Deslattes, R.D.; Lamotte, M.; Dewey, H.J.; Keller, R.A.; Freund, S.M.; Ritter, J.J.; Braun, W.; Kurylo, M.J. (National Bureau of Standards, Washington, DC). pp 296-303 of In Laser spectroscopy. Haroche, S.; Pebay-Peyroula, J.C.; Haensch, T.W.; Harris, S.E. (eds.). New York, Springer-Verlag (1975).

From Conference on laser spectroscopy; Megeve, France (23 Jun 1975).

See CONF-7506103—.

Laser technology has permitted more efficient study of the chemistry of molecules in excited states. The extent to which isotopic specificity is preserved in going from initial excitation to final product is a valuable diagnostic for excited state chemistry. Initial results are summarized from several areas of investigation, each of which suggests that laser stimulation may offer more than simple rate enhancement. (MHR)

3701 Correlation of noise and of striations in the positive column of the cataphoretic He—Cd-laser. Fromm, D.; Schmidt, E. (Osram-Forschung, Munich). *Z. Naturforsch., a;* **30**: 372-380(Mar 1975). (In German).

The noise of the laser signal of the cataphoretic He-Cd-laser (441.6 nm) and the spontaneous emission were investigated spectroscopically in end-on and side-on observation as function of Cd and He atom density. Commencing with Cd atom densities of 500 trillion/cm^3 whitish and blue striations of the positive column develop, that are directly connected with a sinoidal modulation of the voltage and the Cd, Cd(+), and He emissions. Electron temperature and Cd(+) density are higher in the whitish zones than in the blue zones. The noise is attributed to plasma disturbances for example Cd density fluctuations. The striations are explained on the basis of Wojaczek's theory of electron temperature waves.

3702 Optical dielectric waveguide as a quantum light amplifier. Shevelevich, R.S.; Konarev, V.P.; Tabrin, V.N.; Matveev, I.N.; Kliuchkov, Yu.A.; Pshenichnikov, S.M. *Opt. Spektrosk.;* **38**: 1188-1190(Jun 1975). (In Russian).

Amplification properties of laser waveguides are examined. It is shown that in the important practical case when passive absorption is of the order of 0.01 to 0.001 per cm, excitation losses depend on the ratio between the effective coefficient of passive losses in the waveguide and that of the source material. Field moderation in a laser waveguide is shown to be the cause of an increase in the amplification coefficient. Concrete results are presented for a study of amplification in optical fibers. (IAA)

3703 Tunable spin-flip Raman laser. II. Continuous wave molecular spectroscopy. Butcher, R.J.; Dennis, R.B.; Smith, S.D. (Heriot-Watt Univ., Edinburgh). *Proc. R. Soc. (London), Ser. A;* **344**: No. 1639, 541-561(12 Aug 1975).

Results are presented for gas-phase molecular spectroscopy of nitric oxide, carbonyl sulfide, stibine, water vapor, and deuterium bromide which was conducted to obtain frequency calibrations and linewidth measurements of the cw spin-flip Raman laser over the range from 5.27 to 5.5 microns. Two operating regimes of this laser were investigated. It is shown that the output in the spin-saturated regime was continuously tunable to within 100 MHz with a linewidth of about 300 MHz, while the output in the cavity-mode limited regime was characterized by discontinuous tuning with mode-pulling effects and a linewidth some two orders of magnitude lower. Results of a complete band analysis of several vibration-rotation transitions in carbonyl sulfide are found to be in good agreement with previous data, indicating that the present laser is a powerful spectroscopic tool even with its poorest resolution. (IAA)

3704 Shape of passively mode-locked laser pulses. Haus, H.A.; Shank, C.V.; Ippen, E.P. (Bell Telephone Labs., Inc., Holmdel, NJ). *Opt. Commun.;* **15**: 29-31(Sep 1975).

A new theory is outlined which gives closed form solutions for the shape of passively mode-locked laser pulses. The theory is compared with experimental results obtained from background-free autocorrelation measurements of mode-locked dye laser pulses. (IAA)

3705 Theory and experiment of low transitions in CO discharge lasers. Sidney, B. (Langley Research Center, Hampton, VA); McInville, R.M.; Hassen, H.A. *AIAA (Am. Inst. Aeronaut. Astronaut.) J.;* **14**: No. 7, 923-929(Jul 1976).

A self-consistent model, which couples the kinetics of the electrons and heavy particles with the optical and fluid dynamic processes, has been employed to identify the various parameters and explain the mechanism responsible for producing low-lying transitions in slow-flowing CO lasers. Both theory and experiment indicate that lasing on low-lying transitions can be achieved at low temperatures for low pressures (or low-flow rates) together with high partial pressures of He and N_2. The role of N_2 has been identified as an additive responsible for reducing the electron temperature to a range at which the transfer of electrical power to the lower vibrational modes of CO is optimum.

3706 Simplified model of a continuous wave diffusion-type chemical laser: an extension. Mirels, H. (Aerospace Corp., El Segundo, CA). *AIAA (Am. Inst. Aeronaut. Astronaut.) J.;* **14**: No. 7, 930-939(Jul 1976).

The simplified two-vibrational-level model of a cw diffusion-type chemical laser presented by Mirels, Holfland, and King is extended to include multiple vibrational levels. Both laminar and turbulent diffusion are considered. Expressions for axial gain distribution and net output power from a Fabry-Perot optical resonator are deduced. For a given lasing species, the resulting cw chemical laser scaling laws are the same as those previously deduced by Mirels, Hofland, and King, except for the dependence of certain coefficients on rotational quantum number J and temperature T. Broadwell previously presented a multiple-vibrational-level model

for a cw chemical laser that was limited, however, to turbulent diffusion. The flame-sheet-mixing model used in the present study is shown to give results that are identical with those from the scheduled-mixing model of Broadwell when mean chemical rates are used.

HEAT TRANSFER AND FLUID FLOW

REFER ALSO TO CITATION(S) 2286, 2817, 3039, 3053, 3138, 3144, 3200, 3213, 3250, 3405, 3418

3707 (SAND—76-8232) **Momentum and energy transport in the accelerated fully rough turbulent boundary layer.** Coleman, H.W. (Sandia Labs., Livermore, Calif. (USA)). Jun 1976. Contract E(29-1)-789. 164p. Dep. NTIS $6.75.

Thesis.

The behavior of the fully rough turbulent boundary layer subjected to favorable pressure gradients was investigated experimentally using a porous test surface composed of densely packed spheres of uniform size. Measurements of profiles of mean velocity, mean temperature and the components of the Reynolds stress tensor are reported for both unblown and blown layers. Stanton numbers were determined from energy balances on the test surface and skin friction coefficients from measurements of the Reynolds shear stress and mean velocity. A new acceleration parameter, K/sub r/, for fully rough layers is defined and shown to be dependent on a characteristic roughness dimension but independent of molecular viscosity. For fully rough turbulent flow, acceleration causes an increase in Stanton number compared to zero pressure gradient values at the same enthalpy thickness, Reynold number, or position. The fully rough Stanton number behavior observed in this study is contrary to that previously reported for unblown accelerated smooth wall layers. Acceleration of a fully rough layer decreases the normalized turbulent kinetic energy and makes the turbulence field much less isotropic in the inner region (for F equal zero) compared to zero pressure gradient fully rough layers. Increasing values of roughness Reynolds number with acceleration indicate that the fully rough layer does not tend toward the transitionally rough or smooth wall state when accelerated.

3708 **Iterative implicit characteristic method for one-dimensional fluid flow.** Nakamura, S. (Ohio State Univ., Columbus). *Trans. Am. Nucl. Soc.*; **23**: 195-196(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3709 **Constitutive equation for relative motion in two-phase annular flow.** Ishii, M.; Chawla, T.C. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.*; **23**: 349-350(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

MATERIALS TESTING

REFER ALSO TO CITATION(S) 3388, 3781, 3783

3710 **High voltage pulse generator.** Fasching, G.E. (to Energy Research and Development Administration). US Patent Application 586,460. 12 Jun 1975. 10p.

An improved high-voltage pulse generator is described which is especially useful in ultrasonic testing of rock core samples. An N number of capacitors are charged in parallel to V volts and at the proper instance are coupled in series to produce a high-voltage pulse of N times V volts. Rapid switching of the capacitors from the paralleled charging configuration to the series discharging configuration is accomplished by using silicon-controlled rectifiers which are chain self-triggered following the initial triggering of the first rectifier connected between the first and second capacitors. A timing and triggering circuit is provided to properly synchronize triggering pulses to the first SCR at a time when the charging voltage is not being applied to the parallel-connected charging capacitors. The output voltage can be readily increased by adding additional charging networks. The circuit allows the peak level of the output to be easily varied over a wide range by using a variable autotransformer in the charging circuit.

SAFETY ENGINEERING

REFER ALSO TO CITATION(S) 3155, 4016

3711 **Introduction to fault tree analysis.** Barlow, R.E. (Univ. of California, Berkeley); Lambert, H.E. pp 7-35 of In Reliability and fault tree analysis. Barlow, R.E. (ed.). Philadelphia; Society for Industrial and Applied Mathematics (1975).

From Conference on reliability and fault tree analysis; Berkeley, California, USA (3 Sep 1974).

See CONF-740906—.

An elementary, engineering oriented introduction to fault tree analysis is presented. The basic concepts, techniques and applications of fault tree analysis, FTA, are described. The two major steps of FTA are identified as (1) the construction of the fault tree and (2) its evaluation. The evaluation of the fault tree can be qualitative or quantitative depending upon the scope, extensiveness and use of the analysis. The advantages, limitations and usefulness of FTA are discussed.

3712 **Safety simulation language for chemical processes: a procedure for fault tree synthesis.** Powers, G.J. (Carnegie-Mellon Univ., Pittsburgh); Tompkins, F.C.; Lapp, S.A. pp 57-75 of In Reliability and fault tree analysis. Barlow, R.E. (ed.). Philadelphia; Society for Industrial and Applied Mathematics (1975).

From Conference on reliability and fault tree analysis; Berkeley, California, USA (3 Sep 1974).

See CONF-740906—.

A simulation language has been developed for the safety analysis of chemical processing systems. The language provides a general means for producing simulation models for a wide range of chemical processing systems. Boolean models which describe the safety performance of individual chemical processing units are linked together to describe the performance of complete processing systems. Data on properties of the materials and equipment within the process are used to formulate Boolean equations for potential system hazards (explosion, fire, overpressure, release of toxic material, etc.). These hazards are evaluated to determine their economic importance. The primal events (valve failure, power failure, etc.) which could cause each hazard are determined by symbolically solving the Boolean equations which simulate the process. This solution is a fault tree. The probability of occurrence of the system hazard is computed given the probabilities of occurrence of the primal events.

VACUUM ENGINEERING

REFER ALSO TO CITATION(S) 3741

3713 (UCID—17155) **Variable orifice for differential pumping in a vacuum system.** Beeman, R.; Brajkovich, S. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 11 Jun 1976. Contract W-7405-Eng-48. 4p. Dep. NTIS $3.50.

In differential pumping, the pumping speed has in the past been controlled by the size of the orifice between the vacuum chamber and the diffusion pump. This fixed orifice is usually in the valve gate of a high-vacuum valve (or in a baffle plate). To change the pumping speed, then, the valve must be removed and another valve with an orifice of a different size must be inserted. This process is time consuming and risks contamination of the system, which would require another pumpdown and bakeout. A simple shutter that controls pumping speed without requiring any change in components has been developed. The shutter consists of 20 leaves arranged as an iris that opens to a 6-in.-dia orifice or closes to 0.25 in. The shutter consists of a mounting ring, the leaves, a drive ring, and a drive gear. Each leaf is stainless steel with a pivot pin at one end and an offset pin at the other. The leaves are placed in the mounting ring and the drive ring and the drive gear are attached. Rotating the drive gear moves the leaves and changes the orifice size. One of the shutters has been used successfully with a 4-in. diffusion pump system. In this system the pressure is 100 μ in the vacuum chamber and 0.0001 μ at the diffusion pump. The shutter was placed above the cold trap so it could be used for both diffusion pumping and roughing.

ELECTRONIC CIRCUITS AND DEVICES

REFER ALSO TO CITATION(S) 3710

3714 (BDX—613-1297(Rev.)) **Automatic rf-network analyzer as a support tool for engineering and manufacturing.** Taylor, J.L. (Bendix Corp., Kansas City, Mo. (USA)). Aug 1976. Contract E(29-1)-613. 105p. Dep. NTIS $5.50.

Use of a Hewlett-Packard Model 8542-A Automatic Network Analyzer, with selected options, in Bendix engineering applications has resulted in significant direct cost savings and indirect

benefits to product quality. The analyzer is not only more rapid than manual rf measurement methods, but the improved accuracy and the many additional measurements performed by the automatic analyzer provide more-complete engineering data, thereby improving product quality. Additional benefits are anticipated from adoption of a similar analyzer for manufacturing in-process and final inspection operations.

3715 (BDX—613-1381(Rev.)) **Digital recording and analysis of fast EBW burst waveforms.** Lembke, J.R. (Bendix Corp., Kansas City, Mo. (USA)). Aug 1976. Contract E(29-1)-613. 18p. Dep. NTIS $3.50.

A commercial transient digitizer with 10-nanosecond resolution was applied to the measurement of exploding bridgewire dynamic test waveforms. A vidicon digitizer was built to extend the resolution for this type of measurement to less than 1 ns. Both digitizers were interfaced to a minicomputer to permit automatic evaluation of waveform characteristics and computation of functions of two simultaneous waveforms.

3716 (BDX—613-1412(Rev)) **Roller lamination of medium temperature flex circuits.** Peterkort, W.G. (Bendix Corp., Kansas City, Mo. (USA)). Aug 1976. Contract E(29-1)-613. 21p. Dep. NTIS $3.50.

Roller lamination of medium temperature flex circuits was investigated. The experimental laminator was modified prior to the study. Kapton coverlay from several vendors was evaluated and process definition was developed for the production of certain flex circuit and base laminate configurations. Production machine specifications were established.

3717 **Computer aided fault tree construction for electrical systems.** Fussell, J.B. (Aerojet Nuclear Co., Idaho Falls, ID). pp 37-56 of In Reliability and fault tree analysis. Barlow, R.E. (ed.). Philadelphia; Society for Industrial and Applied Mathematics (1975).

From Conference on reliability and fault tree analysis; Berkeley, California, USA (3 Sep 1974).

See CONF-740906—.

A technique is presented for automated construction of the Boolean failure logic diagram, called the fault tree, for electrical systems. The method is a technique for synthesizing a fault tree from system-independent component characteristics. Terminology is defined and heuristic examples are given for all phases of the model. The computer constructed fault trees are in conventional format, use conventional symbols, and are deductively constructed from the main failure of interest to the individual component failures. The synthesis technique is generally applicable to automated fault tree construction for other types of systems.

SOLID WASTE PROCESSING PLANTS AND EQUIPMENT

REFER ALSO TO CITATION(S) 2570, 3383, 3384

COMBUSTION SYSTEMS

REFER ALSO TO CITATION(S) 3388

PARTICLE ACCELERATORS

DESIGN, DEVELOPMENT, AND OPERATION

3718 (BNL—21664) **Optimizing kaon production.** Berley, D. (Brookhaven National Lab., Upton, N.Y. (USA)). 1 Jun 1976. Contract E(30-1)-16. 22p. (CONF-760644—3). Dep. NTIS $3.50.

From Summer study on kaon physics and facilities; Upton, New York, United States of America (USA) (1 Jun 1976).

Kaon production data is examined with the view toward producing high quality beams in the future. Emphasis is placed upon the low momentum region, below 1 GeV/c, where the behavior of the kaon momentum spectrum is shown to be dominated by strongly momentum dependent kinematic factors. No complete experimental survey of production cross sections at different incident proton energies exists from a single apparatus. Information on relative production yields for different proton energies is important in the choice of parameters for an accelerator constructed primarily as a source of kaons. Data from different accelerators do exist and have been compiled. The key element in understanding how to present the data from different laboratories in a consistent way is an analysis of the effects of target material, target size, and production angle. This analysis not only enables a unification of the data but also indicates simple, useful and powerful principles about optimizing target efficiency. A summary is presented of existing kaon production facilities in the United States. These are all at proton accelerators. The possibility of using electron accelerators as kaon sources is examined. It is found that secondary beam fluxes can be obtained at electron linacs which are comparable to those obtained at proton synchrotrons.

3719 (BNL—21728) **Design of a new low momentum kaon beam for the AGS.** Lazarus, D.M. (Brookhaven National Lab., Upton, N.Y. (USA)). 21 Jun 1976. Contract E(30-1)-16. 19p. (CONF-760644—4). Dep. NTIS $3.50.

From Summer study on kaon physics and facilities; Upton, New York, United States of America (USA) (1 Jun 1976).

The low momentum beam described is to be a unique source of antiprotons as well as kaons. The discussion covers (1) choice of production angle; (2) secondary beams; (3) the use of sector dipole magnets for minimizing aberrations; (4) beam bending magnets; (5) beam separators; and (6) beam acceptance. (PMA)

3720 (LA—6374—MS) **Δt tuneup procedure for the LAMPF 805-MHz linac.** Crandall, K.R. (Los Alamos Scientific Lab., N.Mex. (USA)). May 1976. Contract W-7405-ENG-36. 47p. Dep. NTIS $4.00.

An important part of tuning the LAMPF accelerator is the adjustment of the phases and amplitudes in the 805-MHz linac. The technique used is called the Δt procedure because of the time-of-flight measurements that are required. The theory behind the Δt procedure, a brief description of the hardware, and a description of the many computer programs that have been written to implement the procedure are presented.

3721 (ORNL—5137, pp 106-124) **Accelerators: Heavy-Ion Laboratory.** May 1976.

In Physics Division annual progress report for period ending December 31, 1975.

Work on the new Heavy-Ion Facility project and the Phase II proposal are reviewed, along with ORIC operations and development. Beam-buncher tests and magnet-model studies for separated-sector heavy-ion cyclotrons are reported. The dependence of ^{12}C and ^{16}O charge-state yields on stripper-gas flow was investigated. A proposal for an intense neutron generator for radiation-induced damage (INGRID) is set forth. Development of the ORIC data acquisition system and a gas jet-to-tape transport system is outlined. Investigations of the ORIC harmonic-beam space charge effect are reported. 18 figures, 6 tables. (RWR)

3722 (ORNL—5137, pp 128-132) **Accelerators: Van de Graaff Laboratory.** May 1976.

In Physics Division annual progress report for period ending December 31, 1975.

Operations reports for the tandem van de Graaff, CN van de Graaff, and Oak Ridge Electron Linear Accelerators are given. 1 figure, 3 tables. (RWR)

3723 **Electron beam driven neutron generator.** Roberts, T.G.; Shatas, R.A.; Stettler, J.D. (to Secretary of the Army). US Patent 3,968,378. 6 Jul 1976. Filed date 11 Jul 1974. 6p.

An electron beam driven neutron generator is described. An electron source is connected to a beam forming and guiding section. A target is held by a portion of the beam forming and guiding section and has a magnetic field to control heat conduction by charged particles. Neutrons are produced at the target by interaction of the output from the electron beam source and the material forming the target.

3724 **Beam splitting to improve target life in neutron generators.** Farrell, J.P. (to Radiation Dynamics, Inc.). US Patent 3,968,377. 6 Jul 1976. Filed date 14 Aug 1974. 6p.

In a neutron generator in which a tritium-titanium target is bombarded by a deuterium ion beam, the target half-life is increased by separating the beam with a weak magnetic field to provide three separate beams of atomic, diatomic, and triatomic deuterium ions which all strike the target at different adjacent locations. Beam separation in this manner eliminates the problem of one type ion impairing the neutron generating efficiency of other type ions, thereby effecting more efficient utilization of the target material.

BEAM DYNAMICS, FIELD CALCULATIONS, AND ION OPTICS

3725 (BNL—21681) **Direct doubler-main ring anti p p collisions.** Month, M. (Brookhaven National Lab., Upton, N.Y. (USA)). 19 Jul 1976. Contract E(30-1)-16. 6p. Dep. NTIS $3.50.

An anti p beam is produced from source protons accelerated in the main ring and focused on a target. The anti p beam is captured and accelerated in the doubler, its bunch structure intact, and a proton beam is accelerated in the main ring. The luminosity resulting from the ensuing anti pp collisions is calculated.

3726 (BNL—21682) **Stacking in the Fermilab doubler.** Month, M. (Brookhaven National Lab., Upton, N.Y. (USA)). 14 Jul 1976. Contract E(30-1)-16. 17p. Dep. NTIS $3.50.

The feasibility of stacking beam in a storage ring by the phase displacement technique, i.e. by the accumulation of momentum strips, is determined by a complicated interplay of many factors. Some of these factors are discussed, especially as they relate to stacking beam in the Fermilab doubler ring, but no attempt is made to present a consistent solution. An arbitrary division is made into five subject categories connected with the stacking process: (1) momentum dilution, that is, the dilution of the longitudinal phase space area; (2) rebunching the stack for acceleration; (3) the physical aperture used to create a stack of given current; (4) beam loss during stacking in a superconducting environment; and (5) field errors due to random errors in the placement and support of the superconducting coils, including the amplification of the field errors for orbits displaced from the magnet center. The basic theory is given and applied using doubler parameters.

3727 (RLO—2041-143) **X and γ ray production by template modulated coherent light II.** Csonka, P.L. (Oregon Univ., Eugene (USA). Inst. of Theoretical Science). 1976. Contract E(45-1)-2230. 12p. Dep. NTIS $3.50.

Two features of this earlier proposed device are noted. First, the energy spectrum of the produced X and γ rays can be greatly extended, even if the light frequency is left unchanged by raising the intensity of the incident coherent light to a level where multiple scattering of particles on photons is significant. Second, frequency and polarization control of the emitted photons can be improved by beam bunching.

3728 (RLO—2041-144) **Enhancement of synchrotron radiation by beam modulation.** Csonka, P.L. (Oregon Univ., Eugene (USA)). 1976. Contract E(45-1)-2230. 19p. Dep. NTIS $3.50.

The beam density in storage rings like SPEAR at SLAC is high enough to emit a synchrotron radiation coherently (between electrons) if the beam density is appropriately modulated. Modulation occurs, e.g., by passing the beam through laser light of frequency ω, along a phase matched orbit (as in an undulator). The device will enhance radiation by several decades even at frequencies greater than ω, unlike an undulator, and would greatly improve the performance of an earlier proposed x-ray laser to be pumped by synchrotron radiation.

3729 (LA-tr—76-16) **Transverse steering of two-component beams.** Murin, B.P.; Bondarev, B.U.; Durkin, A.P.; Lomize, L.G.; Soloviev, L.Yu.; Fedotov, A.P. Translated by S.K. Essin from *Tr. Radiotekh. Inst.*; No. 16, 67-80(1974). 16p. Dep. NTIS $3.50.

Coherent transverse oscillations are considered which occur during simultaneous acceleration of proton and H^- beams due to arbitrary displacements in elements of the focusing channel. To suppress these oscillations, a beam adjustment station is proposed, in which each quadrupole lens of two doublets is provided with a special dipole component of the magnetic field. These steering elements, together with the beam transverse position monitors, permit steering the transverse position of beams of opposite signs in both transverse planes. The number of steering stations needed is chosen, and some algorithms for control are discussed. It is shown that some of the control algorithms will permit not only the suppression of coherent oscillations, but a decrease in the radius and emittance of the beam.

3730 **Design considerations and evaluation of the TAMVEC Neutron therapy shield.** Smathers, J.B. (Texas A and M Univ., College Station); Wilson, W.B.; Otte, V.A.; Almond, P.R.; Grant, W. *Trans. Am. Nucl. Soc.*; **23**: 634-635(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

AUXILIARIES AND COMPONENTS

3731 (LA-tr—76-17) **Methods and results of investigation of the loading characteristics of high-power klystron amplifiers.** Egorov, E.N.; Rainer, M.M.; Elsner, I.A. Translated by S.K. Essin from *Tr. Radiotekh. Inst.*; No. 16, 161-171(1974). 14p. Dep. NTIS $3.50.

A method is described for constructing the loading characteristics of klystron amplifiers by using a small number of measured points, based on a two-dimensional polynomial approximation with the help of a computer. A klystron was investigated which will be used to feed radiofrequency power to a high-current proton accelerator; the influence of the operational regime of the klystron on the loading characteristics of this klystron was studied. A program for approximation of the loading diagram by using 10 to 15 measurements was developed. This approximation was done by using a 4th order polynomial and gives an accuracy not worse than 5 percent.

3732 **Neutron spectrum from 20 to about 600 MeV above the Brookhaven National Laboratory AGS shielding.** Madey, R.; Baldwin, A.R.; Waterman, F.M. (Kent State Univ., OH). *Trans. Am. Nucl. Soc.*; **23**: 612-613(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3733 **Automatic frequency control system for driving a linear accelerator.** Helgesson, A.L. (to SHM Nuclear Corp.). US Patent 3,965,434. 22 Jun 1976. Filed date 1 Dec 1972. 12p.

An automatic frequency control system is described for maintaining the drive frequency applied to a linear accelerator to produce maximum particle output from the accelerator. The particle output amplitude is measured and the frequency of the radio frequency source powering the linear accelerator is adjusted to maximize particle output amplitude.

3734 **Device, in particular a neutron generator, having a detachable high-voltage connection.** Reifenschweiler, O. (to US Philips Corp.). US Patent 3,968,373. 6 Jul 1976. Priority date 12 Sep 1973, Netherlands. 4p.

A neutron generator having a high voltage connection is described. A gap between a first and a second insulator of the high voltage connection is filled with an insulating liquid, preferably oil. The oil flows and preferably also serves for cooling parts at high voltage of the device, for example an ion source. As a result, the dielectric strength of the device is considerably improved.

3735 **Source of spin polarized electrons.** Pierce, D.T.; Meier, F.A.; Siegmann, H.C. US Patent 3,968,376. 6 Jul 1976. Priority date 13 Jan 1975, Switzerland. 6p.

A method is described of producing intense beams of polarized free electrons in which a semiconductor with a spin orbit split valence band and negative electron affinity is used as a photocathode and irradiated with circularly polarized light.

ION SOURCES

3736 (ORNL—5137, pp 124-128) **Accelerators: ion-source-development program.** May 1976.

In Physics Division annual progress report for period ending December 31, 1975.

Operation of the negative-ion-source test facility is recounted. Development and testing of the Middleton—Adams sputter source and the charge-exchange source are reviewed. The results of a preliminary evaluation of the Mueller—Hortig-geometry negative-ion source are described. 3 figures, 2 tables. (RWR)

3737 **Electron-bombardment ion source including segmented anode of electrically conductive, magnetic material.** Reader, P.D.; Kaufman, H.R. (to Ion Tech, Inc.). US Patent 3,969,646. 13 Jul 1976. Filed date 10 Feb 1975. 10p.

An electron-bombardment ion source has a chamber into which an ionizable propellant is introduced. Electrons flowing from a cathode to an anode serve to ionize the propellant. The resulting ions are accelerated out of the chamber. To increase the efficiency of ionization of the propellant by the electrons, a magnetic field is established within the chamber. To that end, there are a plurality of successively spaced segments of electrically conductive magnetic material. The segments are interconnected so as, collectively, to serve as the anode. Individually adjacent ones of the segments are respectively polarized as magnetic opposites, the segments together serving to establish the magnetic field.

EXPERIMENTAL FACILITIES AND EQUIPMENT

REFER ALSO TO CITATION(S) 3721

3738 (LBL—4824) **Large high current density superconducting solenoids for use in high energy physics experiments.** Green, M.A.; Eberhard, P.H.; Taylor, J.D. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). May 1976. Contract W-7405-ENG-48. 20p. (CONF-760508—5). Dep. NTIS $3.50.

From 6. ICED meeting; Grenoble, France (11 May 1976).

Very often the study of high energy physics in colliding beam storage-rings requires a large magnetic field volume in order to detect and analyze charged particles which are created from the collision of two particle beams. Large superconducting solenoids which are greater than 1 meter in diameter are required for this kind of physics. In many cases, interesting physics can be done outside the magnet coil, and this often requires that the amount of material in the magnet coil be minimized. As a result, these solenoids should have high current density (up to 10^9 A m^{-2}) superconducting windings. The methods commonly used to stabilize large superconducting magnets cannot be employed because of this need to minimize the amount of material in the coils. A description is given of the Lawrence Berkeley Laboratory program for building and testing prototype solenoid magnets which are designed to operate at coil current densities in excess of 10^9 A m^{-2} with magnetic stored energies which are as high as 1.5 Megajoules per meter of solenoid length. The coils use intrinsically stable multifilament Nb—Ti superconductors. Control of the magnetic field quench is achieved by using a low resistance aluminum bore tube which is inductively coupled to the coil. The inner cryostat is replaced by a tubular cooling system which carries two phase liquid helium. The magnet coil, the cooling tubes, and aluminum bore tube are cast in epoxy to form a single unified magnet and cryogenic system which is about 2 centimeters thick. The results of the magnet coil tests are discussed.

3739 **Tritium target for neutron source.** Ormrod, J.H. (to Atomic Energy of Canada, Ltd.). US Patent 3,963,934. 15 Jun 1976. Priority date 16 May 1972, Canada. 4p.

A tritium target for a neutron source consists of: a target layer of tritiated titanium sandwiched between layers of aluminum oxide which act to inhibit diffusion of tritium out of the target layer; a layer of aluminum on the front or beam side of said target to act as a sputter shield; a metallic backing layer behind the target; and cooling means adjacent the backing layer for cooling the target and absorbing and diffusing stopped deuterons.

3740 **Shutter designed to block high-energy particle beams.** Donnadille, B. (to CGR-Mev.). US Patent 3,963,935. 15 Jun 1976. Priority date 9 Apr 1974, France. 4p.

A description is given of a shutter designed for temporarily closing off an opening formed in the wall of an irradiation room for the passage of a particle beam. A cylindrical metal block can rotate about its axis and occupy two stable positions which are 180° from one another. A cylindrical cage closed at its two ends by two circular plates is equipped respectively with eccentric holes for the passage of the particle beam. The block is provided with a longitudinal passage through which there can pass the particle beam and a blind hole or "pit" disposed symmetrically to the longitudinal passage and which can block the particle beam according to the positioning of the block by respect with the eccentric holes.

STORAGE RINGS

REFER ALSO TO CITATION(S) 3728

3741 (BNL—21615) **Behavior of titanium sublimation and sputter ion pumps in the 10^{-11} torr range.** Halama,. H.J. (Brookhaven National Lab., Upton, N.Y. (USA)). 1976. Contract E(30-1)-16. 34p. (CONF-760921—2). Dep. NTIS $4.00.

From 23. National vacuum symposium; Chicago, Illinois, United States of America (USA) (21 Sep 1976).

In the proposed Intersecting Storage Accelerator, ISABELLE, 1200 pumping stations will be used to keep two 3 km long rings at a pressure of 1 x 10^{-11} torr. It is clear that in such a large system, price and simplicity are very important. A study was made on a well instrumented room temperature vacuum system with a surface area of 6000 cm^2 and a volume of 17 l, pumped by a Ti-ball and an ion pump. Total pressure and residual gas composition were measured by a Helmer gauge and a quadrupole mass spectrometer. The final pressures of approximately 1 x 10^{-11} torr were reached with Ti films and a 20 $l\ s^{-1}$ sputter-ion pump. The main residual gas components were hydrogen and methane. The ultimate pressure was determined primarily by the ability of Ti films to pump H_2 which depends on the method of laying down the film and the surface temperature. Previous surface preparation seemed relatively unimportant. Two methods of pumping CH_4 were investigated: (1) cracking the molecules on hot tungsten filament; and (2) conventional sputter-ion pumping. Sputter-ion pumping was found to be more efficient and preferable.

INSTRUMENTATION

RADIATION INSTRUMENTATION

GENERAL DETECTORS AND MONITORS

REFER ALSO TO CITATION(S) 2719, 2762, 2889, 2975, 3004, 3042, 3065, 3922, 3992, 3995, 4161, 4200

3742 (ANL—75-49, pp 31-41) **Development of liquid scintillation neutron detectors.** Greenwood, L.R.; Chellew, N.R. 1975.

In Chemical Engineering Division, fast-neutron dosimetry annual report, July 1974—June 1975.

Progress is reported on the development of ^{10}B-loaded liquid scintillators for the detection of neutrons that have intensities at the point of detection that are comparable to the intensity of the ambient neutron background. Test results of 2-in. and 5-in. ^{10}B-loaded cells for light output and pulse-shape discrimination (PSD) are reported, as well as the results of performance tests of commercially supplied scintillator solutions. A description is given of the dry-nitrogen-atmosphere box used in preparing high-purity materials needed in the preparation of the ^{10}B-loaded liquid scintillator solutions. Results of light transmission calculations and tests of light piping are presented. Further testing of large cells will be required to determine light transmission characteristics; however, test results of light piping indicate reduced sensitivity in cell performance. A Monte Carlo computer code has been modified and implemented for the theoretical calculations of cell neutron efficiencies for incident neutron energies up to 20 MeV. Calculations were made of the fraction of 477 keV γ rays that will be captured in a cell owing to the $^{10}B(n,\alpha)^7Li$ reaction, and the most practical cell thickness was determined to be about 2 in. Exploratory investigations of other liquid scintillators indicate that the use of 1-methyl naphthalene in place of other intermediate solvents may increase cell performance. Other compounds, such as ^6Li-loaded materials, are also being investigated.

3743 (ERDA-tr—125, pp 240-250) **Calculation of the sensitivity of a spherical neutron detector.** Utkin, V.A. 1974. Translated from pp 182-190 of Voprosy fiziki zashchity reaktorov, vypusk 6, Atomizdat, Moscow, 1974.

In Questions on the physics of reactor shielding. Volume 6.

Functionals for determining the sensitivity of a neutron detector inside a cavity in a spherical moderator are derived.

3744 **Comparison of coded aperture imaging systems containing zone plate and random-phase code functions.** Whitehead, F.R. Tucson, AZ; Univ. of Arizona (1976). 112p. University Microfilms Order No. 76-18,249.

Thesis (Ph. D.).

Coded aperture imaging systems provide an alternative to the conventional pinhole camera imaging system normally used for producing images of gamma-ray and x-ray emitting objects. The coded aperture system uses a large, highly structured aperture in place of the single pinhole aperture, so that the resulting image is a complex pattern of overlapping shadows, produced by the convolution of the aperture transmittance function with the object radiance distribution function. When the aperture transmittance function is properly chosen, it is possible to use a second imaging step to obtain the desired image of the original object radiance distribution. The use of a coded aperture system and its two-step imaging process has two important advantages over the conventional, pinhole imaging system with its single-step imaging process. First, for objects which consist of non-overlapping point sources, such as star fields, the coded aperture imaging system offers greater efficiency and increased signal-to-noise ratio. Second, for both point sources and extended objects, the coded aperture imaging system records three-dimensional information from a single view of the object.

3745 **On-axis Fresnel zone plate imaging system with a germanium gamma ray camera and computer reconstruction.** Kelly, K.A. Columbus, OH; Ohio State Univ. (1976). 248p. University Microfilms Order No. 76-17,995.

Thesis (Ph. D.).

This study examines the feasibility of obtaining germanium gamma camera images by using a Fresnel zone plate aperture to produce shadowgrams and by digital reconstruction of images from the shadowgrams produced. The germanium camera is expected to provide high resolution images in nuclear medicine, but a conven-

tional aperture for forming a high resolution image would result in very low gamma ray collection efficiency. The zone plate aperture is intended to improve this efficiency for imaging small sources, and in addition, to provide three-dimensional information about the source of radiation. The Fresnel zone plate imaging system is designed and evaluated by means of computer studies. Parametric equations relating zone plate, detector, and field of view parameters are derived. Based on these equations, a general method of designing a zone plate system for any detector is established, and this method is applied to a system with a square high-purity germanium detector, measuring 15.3 cm on a side. The zone plate parameters for optimum system resolution are calculated. The theoretical spatial resolution of the system considered here is 1.7 mm, which is better than that of the camera itself, 2.4 mm. In this case, the field of view of the system is restricted to a square field, 11 cm on a side. The field of view can be increased at the expense of degrading system resolution. For resolutions of 2.4 mm and 3.7 mm, the fields of view are squares of length 15.3 cm and 23.6 cm, respectively.

3746 Multiwire proportional chambers in nuclear medicine: present status and perspectives. Perez-Mendez, V. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.); Kaufman, L.; Lim, C.B.; Price, D.C.; Blumin, L.; Cavalieri, R. *Int. J. Nucl. Med. Biol.*; 3: No. 1, 29-33(Jan 1976).

The construction and operating characteristics of xenon-filled Multiwire Proportional Chambers (MRPC) for nuclear medicine imaging are described. The resolution and image quality of these devices is demonstrated by various images taken with γ-rays ranging in energy from 28 to 140 keV. From measurements done with a 4 atm chamber, it was estimated that 10 atm xenon-filled chambers could provide a satisfactory combination of resolution (2 mm) and detector efficiency for use with γ-rays in this energy range. Other uses of MWPC include positron imaging and X-ray crystallography.

3747 Activation neutron detector. Ambardanishvili, T.S.; Kolomiitsev, M.A.; Zakharina, T.Y.; Dundua, V.J.; Chikhladze, N.V. US Patent 3,931,523. 6 Jan 1976. Filed date 8 Nov 1973. 12p.

An activation neutron detector made as a moulded and cured composition of a material capable of being neutron-activated is described. The material is selected from a group consisting of at least two chemical elements, a compound of at least two chemical elements and their mixture, each of the chemical elements and their mixture, each of the chemical elements being capable of interacting with neutrons to form radioactive isotopes having different radiation energies when disintegrating. The material capable of being neutron-activated is distributed throughout the volume of a polycondensation resin inert with respect to neutrons and capable of curing. 17 Claims, No Drawings.

3748 Gamma counter shutter assembly. Aday, R.W. Jr.; Barber, D.G. (to Beckman Instruments, Inc.). US Patent 3,932,752. 13 Jan 1976. Filed date 19 Feb 1974. 6p.

A shutter assembly for a radioactivity measuring apparatus is described having a sample counting chamber, the assembly having a bulky solid lead cylinder with a sample access port extending therethrough for alignment with the sample chamber. The cylinder is rotated by a Geneva wheel arrangement having a drive wheel with a plurality of equi-angularly disposed pins perpendicular to the surface thereof engaging radially extending open-ended slots in a driven wheel secured to the lead cylinder for concurrent rotation therewith. The drive wheel is rotated at a constant speed with the driven wheel accelerating as a pin traverses the slot from the open end toward the driven wheel center and then decelerating as the pin traverses the reverse direction to provide precise positioning with adjacent pins engaging the open ends of adjacent slots in the stop position of the cylinder. 8 Claims, 3 Drawing Figures.

3749 Detector for ionizing radiation. Prag, R. (to Siemens Aktiengesellschaft). US Patent 3,934,143. 20 Jan 1976. Priority date 10 Nov 1972, German, Federal Republic of (F.R. Germany). 6p.

A detector for ionizing radiation is described comprising a semiconductor plate having electrode strips, which extend along the upper surface of the plate, which is passed through by the rays, from an edge portion of the semiconductor plate in the direction of its opposite edge portion, and which communicate with a signal utilizing arrangement, the latter of which forms signals from the signals tapped from the electrode strips in correspondence with or indicative of the locations of the focal points of the radiation spots produced on the detector. All electrode strips are positioned on one side of the semiconductor plate, and vary in cross-section along the direction of their longitudinal extension pursuant to a predetermined function, and wherein on the other side of the semiconductor plate there is mounted a common electrode covering substantially the entire surface of the plate. 5 Claims, 3 Drawing Figures.

3750 Proportional counter end effects eliminator. Meekins, J.F. (to Secretary of the Navy). US Patent 3,934,165. 20 Jan 1976. Filed date 25 Oct 1974. 4p.

An improved gas-filled proportional counter which includes a resistor network connected between the anode and cathode at the ends of the counter in order to eliminate "end effects" is described. 3 Claims, 2 Drawing Figures.

3751 Collimator kit. Jonker, R.R. US Patent 3,936,646. 3 Feb 1976. Filed date 29 Nov 1973. 10p.

A collimator kit having a number of parts which may be assembled in various combinations to provide focusing collimators with different performance characteristics for radioisotope imaging apparatus is described.

3752 Radiographic imaging system for high energy radiation. Barrett, H.H. (to Raytheon Co.). US Patent 3,936,639. 3 Feb 1976. Filed date 1 May 1974. 28p.

A radiographic imaging system for high energy radiation utilizing a detector of such radiation and a mask having regions relatively transparent to such radiation interspersed among regions relatively opaque to such radiation is described. A relative motion is imparted between the mask and the detector, the detector providing a time varying signal in response to the incident radiation and in response to the relative motion. The time varying signal provides, with the aid of a decoder, an image of a source of such radiation.

3753 Scintillation camera with second order resolution. Muehllehner, G. (to G. D. Searle and Co.). US Patent 3,937,964. 10 Feb 1976. Filed date 21 Jun 1974. 10p.

A scintillation camera for use in radioisotope imaging to determine the concentration of radionuclides in a two-dimensional area is described in which means is provided for second order positional resolution. The phototubes, which normally provide only a single order of resolution, are modified to provide second order positional resolution of radiation within an object positioned for viewing by the scintillation camera. The phototubes are modified in that multiple anodes are provided to receive signals from the photocathode in a manner such that each anode is particularly responsive to photoemissions from a limited portion of the photocathode. Resolution of radioactive events appearing as an output of this scintillation camera is thereby improved.

3754 Liquid scintillation systems and apparatus for measuring high-energy radiation emitted by samples in standard laboratory test tubes. Benvenutti, R.A. (to Meloy Labs., Inc.). US Patent 3,937,961. 10 Feb 1976. Filed date 18 Jan 1974. 8p.

Liquid scintillation detection system employs improved sample holders in which the cap of a glass vial is provided with a well for receiving a standard laboratory test tube containing a radioactive sample. The well is immersed in a liquid scintillator in the vial, the scintillator containing lead acetate solution to enhance its efficiency. A commercially available beta-counting liquid scintillation apparatus is modified to provide gamma-counting with the improved sample holders.

3755 Shielded-emitter neutron detector. Klar, E. (to Siemens Aktiengesellschaft). US Patent 3,940,627. 24 Feb 1976. Priority date 1 Aug 1973, German, Federal Republic of (F.R. Germany). 4p.

A self-powered neutron detector has a neutron-sensitive emitter, a collector enclosing this emitter and insulation between these two components. When irradiated by neutrons, the emitter generates Compton electrons so that a current is produced between the emitter and electrode and which may be used with a current-measuring device to provide a readout. The emitter is enclosed and electrically connected with a metal which is substantially neutron-insensitive so that the detector provides a substantially true and prompt signal accurately reflecting the neutron flux density received by the detector.

3756 Fast charge digitizer and digital data acquisition system for measuring time varying radiation fields. Lee, T.R.; Schneider, R.H.; Wyatt, J.L. (to Secretary of the Department of Health, Education and Welfare). US Patent 3,959,653. 25 May 1976. Filed date 14 Apr 1975. 12p.

A radiation measuring instrument including a fast charge digitizer and a digital data acquisition system has been developed. The fast charge digitizer includes a charge integrator connected to a conventional ionization chamber which generates an output current in proportion to ionizing radiation exposure rate. The charge integrator has an output connected to a comparator which is switched from a high state to a low state when the output of the integrator goes above the comparator threshold. The comparator

output is connected to a bistable multivibrator consisting of two non-retriggerable one shot multivibrators connected in a feedback configuration. As long as the comparator output is in the low state, the bistable multivibrator generates a train of pluses which are fed back through an analog switch and a high megohm resistance to the input of the integrator. This feedback is negative and has the effect of removing the charge from the integrating capacitor, thus causing the integrator output eventually to drop below the comparator threshold. When this occurs the comparator output returns to the high state and the bistable multivibrator ceases to generate output pulses. An output terminal is connected between the bistable multivibrator and the analog switch and feeds a train of pulses proportional to the amount of charge generated by the multivibrator output voltage and the high megohm resistance to a counter connected to a random access memory device. The output pulses are counted for a predetermined time and then stored in one of the data locations of the random access memory device. The counter is then reset and a further predetermined sample period is counted. This continues until all of the locations in the random access memory device are filled and then the data is read from the random access memory device.

3757 Depletion characteristics of beta-decaying SPNDs. Warren, H.D. (Babcock and Wilcox Co., Lynchburg, VA). *Trans. Am. Nucl. Soc.*; **23**: 460-461(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3758 Process and apparatus for scanning sections of radiation. Richey, J.B.; Wake, R.H.; Keller, J.T. (to Ohio Nuclear, Inc.). US Patent 3,970,852. 20 Jul 1976. Filed date 8 Jul 1974. 18p.

The process of this invention includes detecting gamma radiation with a radiation sensing device, converting the gamma radiation to light radiation, viewing the light radiation with photomultiplier tubes and giving electrical impulses in response thereto. The apparatus includes a radiation sensing device for scanning a section of radiation, normally an irradiated patient. The radiation sensing device includes a camera detection head and has a collimator which channels radiation, normally gamma radiation, from the patient to a scintillation crystal operatively attached thereto. The scintillation crystal converts gamma radiation to light radiation which is noted by photomultiplier tubes viewing the scintillation crystal. Electrical responses given by the photomultiplier tubes are operatively attached to means for operating on the electrical impulses to create a signal which gives an indication of the relative location of the radiation. A drive means moves the camera head in a longitudinal direction along a cot supporting the patient. At each end of the mechanical movement of the head, an electronic scanner views the ends of the section of radiation under consideration. Appropriate mechanical drive means moves or indexes the table supporting the patient in a direction transverse to the longitudinal movement of the detector head. A means for blending the radiation received from multiple passes of the detector head includes an electronic mask with oscillating sides. In this manner, multiple passes can be blended without substantial artifacts. A means for sequencing events governs the proper order of events.

RADIATION DOSEMETERS

3759 Particle dosimetry by track etching, with applications to Apollo Astronauts and to heavy radionuclide mapping in biological systems. Fleischer, R.L. (General Electric Research and Development Center, Schenectady, NY). pp 570-580 of In Radiation research. Biomedical, chemical, and physical perspectives. Nygaard, O.F. (ed.). New York; Academic Press, Inc. (1975).

From 5. international radiation research congress meeting; Seattle, Washington, USA (14 Jul 1974).

See CONF-740715—.

Particle track detectors make possible a range of particle dosimetry applications—in uranium mines, in residential homes, in Apollo spacecraft, at nuclear reactors and particle accelerators, and at nuclear weapons plants. The detailed micromapping property of particle track detectors allows localized distributions of alpha emitters in biological substances to be determined and therefore makes possible the calculation of doses that are specific to the biological structures where they are actually received.

3760 Method and apparatus for determining the dose value of neutrons. Burgkhardt, B.; Piesch, E. (to Gesellschaft fuer Kernforschung mbH). US Patent 3,932,758. 13 Jan 1976. Priority date 8 Dec 1972, German, Federal Republic of (F.R. Germany). 10p.

A method is provided for determining the dose value of neutrons leaving a body as thermal and intermediate neutrons after having been scattered in the body. A first dose value of thermal and intermediate neutrons is detected on the surface of the body by means of a first detector for neutrons which is shielded against thermal and intermediate neutrons not emerging from the body. A second detector is used to measure a second dose value of the thermal and intermediate neutrons not emerging from the body. A first correction factor based on the first and second values is obtained from a calibration diagram and is applied to the first dose value to determine a first corrected first dose value. 21 Claims, 6 Drawing Figures.

NUCLEAR SPECTROSCOPIC INSTRUMENTATION

3761 (ERDA-tr—125, pp 191-198) **Measurement of different forms of neutron energy distributions with single-crystal scintillation spectrometer.** Trykov, L.A. 1974. Translated from pp 146-152 of Voprosy fiziki zashchity reaktorov, vypusk 6, Atomizdat, Moscow, 1974.

In Questions on the physics of reactor shielding. Volume 6.

The capabilities of a single-crystal scintillation spectrometer for measurement of neutron spectra are described. The use of the smoothing differentiation method for conversion of amplitude distributions to neutron energy spectra is discussed. The determination of distortions in energy spectra due to deviation of the line from normal when large stilbene crystals are used is also discussed.

3762 (ERDA-tr—125, pp 199-206) **Application of hydrogen spectrometer for spectral analyses of neutrons in reactor shield materials.** Badyaev, V.V.; Egorov, Yu.A.; Kulagin, V.A.; Pankrat'ev, Yu.V. 1974. Translated from pp 152-158 of Voprosy fiziki zashchity reaktorov, vypusk 6, Atomizdat, Moscow, 1974.

In Questions on the physics of reactor shielding. Volume 6.

Data from a feasibility study on the use of a hydrogen-filled proportional counter for analyzing neutron energy distributions in reactor shield materials are presented. The results indicate that hydrogen spectrometers may be used to obtain reliable information on neutron energy distributions in the range above 5 keV.

3763 (ERDA-tr—125, pp 231-239) **Calculation of instrument line form for He^3-neutron spectrometer by Monte Carlo method.** Egorov, Yu.A.; Zharkov, V.P.; Orlov, Yu.V. 1974. Translated from pp 175-182 of Voprosy fiziki zashchity reaktorov, vypusk 6, Atomizdat, Moscow, 1974.

In Questions on the physics of reactor shielding. Volume 6.

A Monte Carlo technique for the conversion of neutron spectra measured in shielding with a ^{3}He spectrometer from instrument distributions to energy spectra is presented.

3764 Gamma-ray response of NE-213 measured between 1 and 11.5 MeV. Ingersoll, D.T.; Wehring, B.W.; Starr, R.D. (Univ. of Illinois, Urbana). *Trans. Am. Nucl. Soc.*; **23**: 631(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3765 Systematic variation of threshold reaction rates in EBR-II. Lippincott, E.P.; Combs, B.L.; Davis, A.I. (Hanford Engineering Development Lab., Richland, WA). *Trans. Am. Nucl. Soc.*; **23**: 636-637(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

HIGH ENERGY PHYSICS INSTRUMENTATION

REFER ALSO TO CITATION(S) 3738

RADIOMETRIC INSTRUMENTS

REFER ALSO TO CITATION(S) 3779

3766 (UCID—17111) **Feasibility study for use of a germanium detector in the LOFT gamma-ray densitometer.** Swierkowski, S.P. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 27 Apr 1976. Contract W-7405-Eng-48. 34p. Dep. NTIS $4.00.

The primary aim of this study is to predict the performance of a gamma-ray densitometer system using computer modeling techniques. The system consists of a collimated ^{137}Cs source, a pipe containing a variable amount of water absorber, and a shielded and collimated germanium detector system. The gamma-ray energy spectrum (number of photon counts as a function of energy) has been computed for several sources at the detector. The response for combined sourceconfigurations has been obtained by linear superposition. The signal essentially consists of the counts in an energy window centered on the ^{137}Cs source at 662 keV that originate from this source. The noise is the background counts in the signal energy window that originate from ^{16}N scatter

radiation and direct and shield tank activation gammas. The detector signal has been computed for 0, 50, and 100 percent water in the pipe. (WHK)

3767 Ionization smoke detector. Sasaki, K.; Kobayashi, A. (to Nittan Co., Ltd.). US Patent 3,935,492. 27 Jan 1976. Filed date 3 May 1973. 4p.

An ionization smoke detector is described having two ionization chambers with one of said chambers having an electrode at least partially surrounded by a conductive mesh constituting an intermediate electrode and the other of said chambers being formed between the intermediate electrode and an outer surrounding electrode of conductive mesh and a radioactive source carried by said outer electrode. The volume defined by the outer and intermediate electrodes is greater than the volume defined by the intermediate electrode.

RADIATION EFFECTS ON INSTRUMENT COMPONENTS, INSTRUMENTS, OR ELECTRONIC SYSTEMS

3768 Method of radiation hardening and gettering semiconductor devices. Mueller, C.W.; Douglas, E.C.; Wu, C.P. (to RCA Corp.). US Patent 3,933,530. 20 Jan 1976. Filed date 28 Jan 1975. 6p.

In one embodiment, a semiconductor device, such as an insulated-gate-field-effect-transistor (IGFET), is simultaneously radiation hardened with Al ions and its threshold voltage stabilized with halide ions, such as Cl ions, by bombarding a silicon dioxide gate insulator of the device with molecular ions of an aluminum halide, such as $AlCl_2^+$ ions. In another embodiment, a surface (target) of silicon is bombarded with molecular $AlCl_2^+$ ions to ion implant separate Al ions and Cl ions. An oxide layer subsequently thermally grown on the bombarded surface includes the Al ions and the Cl ions, and the oxide layer is radiation hardened and gettered.

3769 Radiation detection system. Haeuszer, F.A. (to Secretary of the Air Force). US Patent 3,965,471. 22 Jun 1976. Filed date 13 Aug 1969. 4p.

A circuit is disclosed that detects radiation transients and provides a clamping signal in response to each transient. The clamping signal is present from the time the transient rises above a given threshold level and for a known duration thereafter. The system includes radiation sensors, a blocking oscillator that generates a pulse in response to each sensor signal, and an output pulse duration control circuit. The oscillator pulses are fed simultaneously to the output pulse duration control circuit and to an OR gate, the output of which comprises the system output. The output pulse duration is controlled by the time required to magnetize a magnetic core to saturation in first one direction and then the other.

MISCELLANEOUS INSTRUMENTS

REFER ALSO TO CITATION(S) 2714, 2749, 2773, 2827, 2838, 2878, 2880, 2992, 3041, 3061, 3643, 3651

3770 (INIS-mf—3070) **A study of far-infrared Michelson interferometry based on fast plasma scanning.** Hewitt, G.L.; Robinson, L.C.; Tait, G.D. (Sydney Univ. (Australia). School of Physics). Feb 1976. 43p. INIS.

Fast far-infrared multiplex spectroscopy based on a plasma-scanned Michelson interferometer is studied. Our experiments show that the interferometer has sub-millisecond time response and high spectral resolving power. In addition to a description of the experimental performance of the interferometer, we develop and discuss two different methods of interferogram inversion.

3771 (K/GD—1483) **Hydrogen fluoride gas monitor.** Gentry, W.O. (Oak Ridge Gaseous Diffusion Plant, Tenn. (USA)). 16 Aug 1976. Contract W-7405-eng-26. 8p. Dep. NTIS $3.50.

A hydrogen fluoride (HF) gas monitor has been developed at the Oak Ridge Gaseous Diffusion Plant (ORGDP) to detect small releases of HF in air. The information included in this report on the instrument is as follows: (1) a general description of the instrument; (2) a photograph of a commercial smoke detector (Pyr-A-Larm F-5B, Pyrotronics, Inc., Cedar Knolls, New Jersey) which has been modified for HF detection; (3) a photograph of an HF sensitizer (reagent reservoir assembly); and (4) a detailed drawing of the reagent reservoir.

3772 (UCRL—52087) **Modification of the x-ray diffraction efficiency of lithium fluoride crystals by surface treatment.** Sellick, B.O. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 22 Jul 1976. Contract W-7405-eng-48. 9p. Dep. NTIS $3.50.

Convex-curved crystals of lithium fluoride demonstrate good dispersion and efficiency when used in reflection for x-ray spectral analysis. The crystals are stable and reasonably unaffected by harsh environments. In addition, they are mechanically strong, easily cleavable or machinable, and plastically deformable with heat. In the present study, flat crystal wafers were left either clear as cleaved or were subjected to surface treatment by sandblasting or lapping. Some wafers were then bent in a press mold to obtain convex-curved crystals of differing radii. The diffraction efficiency data presented show how surface treatment affects the efficiency of these various crystals when used as x-ray diffracting agents.

3773 Evacuated refrigerant container as a source of vacuum for air sampling. Griffin, J.D. Jr.; Eutsler, B.C. (Los Alamos Scientific Lab., NM). *Am. Ind. Hyg. Assoc. J.*; 36: No. 11, 845-846(Nov 1975).

An air sampling system utilizing suitable collection media and a converted single-use evacuated Freon container as a source of vacuum is described. Such a system eliminates the explosion hazard of conventional samplers that use electrical pumps and motors. The pre-evacuated system is relatively light-weight, rugged, safe, inexpensive, and needs no electricity during sample collection. However, it is unwieldy to carry several containers for field collection of multiple samples, and the flow rate is not constant throughou the sampling time. (DCM)

3774 Apparatus for determining the energy of charged particles. Schillalies, H.; Barz, A. (to Leybold-Heraeus-GmbH and Co.). US Patent 3,937,957. 10 Feb 1976. Priority date 19 Jun 1973, German, Federal Republic of (F.R. Germany). 4p.

In a device for measuring the energy of charged particles separated from a sample by bombardment with ionizing radiation, which device includes an energy analyzer and an electron lens system disposed between the sample location and the analyzer and including a charged particle deceleration path, the electron lens system is composed of two individual lenses producing an intermediate image between them, with the deceleration path being located between the two lenses to contain the plane of such intermediate image.

3775 Radiation shielding curtain. Winkler, N.T. (to Research Corp.). US Patent 3,967,129. 29 Jun 1976. Filed date 28 Apr 1975. 6p.

A radiation shield is described in the form of a stranded curtain made up of bead-chains whose material and geometry are selected to produce a cross-sectional density that is the equivalent of 0.25 mm or more of lead and which curtain may be mounted on various radiological devices to shield against scattered radiation while offering a minimum of obstruction to the radiologist.

3776 Electrostatic accelerometer and/or gyroscope radioisotope field support device. Browning, A.L. Jr. US Patent 3,965,753. 29 Jun 1976. Filed date 9 Oct 1973. 16p.

An electrode assembly formed by three pairs of electrodes creates a three axis electrical field which surrounds a charged particle confined in a sealed space consisting either of a vacuum or one filled with a selected gas. The field is energizable whereby to support the particle centerably in a state of stable equilibrium. A detector mounted exteriorly with respect to the electrode assembly is responsive to displacement of the particle from the central position, as the result, for example, of acceleration due to gravity or other motion, and a restoring force in operable association with the detectors and the electrical field is triggered by the displacement to return the particle to the central position.

WELL LOGGING INSTRUMENTATION

REFER ALSO TO CITATION(S) 2436, 2440

3777 Pressure transducer. Morris, H.B. (to Seismic Logs, Inc.). Canadian Patent 981,364. 6 Jan 1976. Filed date 16 May 1973. vp.

A pressure transducer consists of two sets of opposed dished crystals mounted in a rigid cylindrical case filled with a damping compound such as silicone fluid. The inner crystals of the sets are connected by a rigid plastic rod and both ends of the case are exposed to the fluid pressure through openings and silicone rubber diaphragms. The crystals are electrically interconnected so that output signals caused by changes in pressure add, whereas output signals due to vibrations cancel.

3778 **Self-propelling apparatus for well-logging tools.** Sheshtawy, A.E. US Patent 3,937,278. 10 Feb 1976. Filed date 12 Sep 1974. vp.

A cylinder filled with a high-density fluid is attached to the top of a logging tool and the structure is allowed to free-fall in a well. After completing a well-logging run on the way down, a powder charge is ignited and the expanding gases push a piston up to expel the fluid from the cylinder. As positive buoyancy is attained, and also due to the fluid and gas jets, the logging tool is propelled upward. At the top of the well the equipment is seized by a latching apparatus.

3779 **Three frequency modulated thermal neutron lifetime log.** Paap, H.J. (to Texaco Inc.). US Patent 3,940,613. 24 Feb 1976. Filed date 17 Jul 1974. 20p.

Methods are disclosed for measuring simultaneously the thermal neutron lifetime of the borehole fluid and earth formations in the vicinity of a well borehole. A harmonically intensity modulated source of fast neutrons is used to irradiate the earth formations with fast neutrons at three different intensity modulation frequencies. Intensity modulated clouds of thermal neutrons at each of the three modulation frequencies are detected by a single spaced detector and the relative phase shift of the thermal neutrons with respect to the fast neutrons is determined at each of the three modulation frequencies. These measurements are then combined to determine simultaneously the thermal neutron decay time of the borehole fluid and the surrounding earth formation media.

EXPLOSIONS AND EXPLOSIVES

REFER ALSO TO CITATION(S) 2387

3780 (LA-UR—76-1445) **Calculations of waves formed from surface cavities.** Mader, C.L. (Los Alamos Scientific Lab., N.Mex. (USA)). 1976. Contract W-7405-eng-36. 15p. (CONF-760727—1). Dep. NTIS $3.50.

From 15. conference on coastal engineering; Honolulu, Hawaii, United States of America (USA) (11 Jul 1976).

The wave motion resulting from cavities in the ocean surface was investigated using both the long wave, shallow water model and the incompressible Navier-Stokes equations. The fluid flow resulting from the calculated collapse of the cavities is significantly different for the two models. The experimentally observed flow resulting from explosively formed cavities is in better agreement with the flow calculated using the incompressible Navier-Stokes model. The resulting wave motions decay rapidly to deep water waves. Large cavities located under the surface of the ocean will be more likely to result in Tsunami waves than cavities on the surface. This is contrary to what has been suggested by the upper critical depth phenomenon.

CHEMICAL

REFER ALSO TO CITATION(S) 3648

3781 (LA-UR—76-1328) **Flash radiographic techniques: exposure, recording, triggering and film protection.** Bryant, L.E. Jr. (Los Alamos Scientific Lab., N.Mex. (USA)). 1976. Contract W-7405-ENG-36. 22p. (CONF-760914—3). Dep. NTIS $3.50.

From American Society for Nondestructive Testing Flash X-Ray symposium; Houston, Texas, United States of America (USA) (27 Sep 1976).

Four aspects of the flash radiographic process are considered with exposure being presented in the form of radiographic technique curves for energies of 180, 300, 480, 600 kV and 2 MeV. The recording of flash x-ray exposures is illustrated with tables giving the relative speeds of frequently used film/screen combinations. Twelve pulsed radiation triggering techniques are described, including photoelectric and contact or "make circuits." Film protection is discussed with examples photographically presented which show how hazards such as over pressure and shrapnel are dealt with.

3782 (LA-UR—76-1425) **Insensitive explosive studies using PHERMEX.** Dick, R.D. (Los Alamos Scientific Lab., N.Mex. (USA)). 1976. Contract W-7405-eng-36. 28p. (CONF-760914—1). Dep. NTIS $4.00.

From American Society for Nondestructive Testing Flash X-Ray symposium; Houston, Texas, United States of America (USA) (27 Sep 1976).

Flash radiographs were obtained of insensitive explosives (mixtures of TATB explosive and Kel-F binder) of several shapes using the PHERMEX flash x-ray facility at the Los Alamos Scientific Laboratory. The purpose was to examine radiographically the corner-turning ability of an insensitive explosive, the character of the expanding detonation wave from a spherical initiation, and the characteristics of colliding detonation waves. A comparison of certain aspects of the corner-turning properties of the insensitive explosive is made with a sensitive explosive (Composition B). Measurements from the radiographs are used to calculate a C-J pressure and a γ value for the insensitive explosives and these are compared to data from sensitive explosives.

3783 (LA-UR—76-1426) **Pulsed high-energy radiographic machine emitting x-rays: PHERMEX.** Dick, R.D. (Los Alamos Scientific Lab., N.Mex. (USA)). 1976. Contract W-7405-ENG-48. 29p. (CONF-760914—2). Dep. NTIS $4.00.

From American Society for Nondestructive Testing Flash X-Ray symposium; Houston, Texas, United States of America (USA) (27 Sep 1976).

The PHERMEX facility that is used to provide radiography of explosives and explosive-driven systems is described. This facility allows precision flash radiography of large objects containing high atomic number materials. The facility consists of a high-current, three-cavity, 27-MeV linear electron accelerator; a 13.5-MW radiofrequency power source; a timing, firing, and signal detection system; and a data acquisition system. PHERMEX was built in the early part of the 1960s to complement other hydrodynamics facilities at Los Alamos and to implement studies related to shock waves, detonation, and other hydrodynamic phenomena. After 15 y of operation and several thousand explosive shots later, PHERMEX has proven to be a very important diagnostic tool in the study of hydrodynamic systems. The attractive features of PHERMEX are the following: very intense submicrosecond 27-MeV bremsstrahlung radiation; 1-mm diam spot size; 100 R at 1 m from a 200-ns pulse; precise determination of edges, discontinuities, and areal mass distribution; and flash radiographs of large explosive systems close to the target.

3784 (MHSMP—75-24H) **HNS crystallization studies. Period covered: April—June 1975.** Sandoval, J. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 1975. Contract DA11173-AMC-487A. 23p. Dep. NTIS $3.50.

An investigation into the crystallization of HNS from DMF solution was undertaken to determine the effects of seeding, agitation, concentration, cooling rate, and related physical factors on the particle characteristics and bulk density of the resulting crystal aggregates. Through selective parameter control, a product of moderate bulk density was obtained. The length to width ratio can be adjusted through hydraulic attrition.

3785 (MHSMP—75-24I) **X-ray diffraction of HNS. Period covered: April—June 1975.** Blair, C.C. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 1975. Contract DA11173-AMC-487A. 9p. Dep. NTIS $3.50.

X-ray diffraction data obtained from HNS (hexanitrostilbene) recrystallized from various solvents are reported. The same x-ray diffraction patterns were observed for all of the HNS samples except dioxane. All of the solvents appear to yield HNS of the same crystal structure. The only basic difference appears to be in the crystal size. HNS-I and HNS-II are not polymorphs. The morphology of HNS-I and -II is different, but this habit variation is caused by something external.

3786 (NVO—410-35) **Project Miracle Play, Humid Water Test, Onsite Radiological Safety, Industrial Hygiene, Safety and Medical Services.** Rosenberry, C.E.; Salazar, A. Jr. (comps.). (Reynolds Electrical and Engineering Co., Inc., Las Vegas, Nev. (USA)). 1976. Contract E(26-1)-410. 25p. Dep. NTIS $3.50.

The Tatum Dome Test Site, located approximately 34 kilometers southwest of Hattiesburg, Mississippi, was the site for the second Humid Water Test in a series of detonable gas explosions of Operation Miracle Play that took place in the cavity created by the Salmon Test, a 5 KT nuclear detonation. In addition, another nuclear detonation, the Sterling Test (0.38 KT), and the Diode Tube Test (Operation Miracle Play), a gas explosion with an assumed yield of 100 tons, were detonated in the same cavity. The Humid Water Test was inadvertently detonated on April 19, 1970. The scheduled readiness date was April 21, 1970. The burial depth was approximately 2,700 feet in the center of the 55-foot radius cavity. The design yield was equivalent to 315 tons of TNT. The explosive mixture consisted of natural gas (99 percent methane) and oxygen, with a mixture of 1.6 to 1 oxygen and methane, respectively. (Some nitrogen was also pumped into the cavity during the purging of the filling lines.) The purpose of the event was to investigate the simulation of blast effect of underground nuclear explosions involving detonable gas mixtures,

and to measure the reduction in seismic motion due to decoupling of explosions in an overdriven cavity. Radiation monitoring activities are described. (CH)

3787 (SAND—76-0151) **Geometrical shock focusing in the flying plate detonator configuration.** Searcy, J.Q. (Sandia Labs., Albuquerque, N.Mex. (USA)). Jul 1976. Contract E(29-1)-789. 24p. Dep. NTIS $3.50.

Two dimensional hydrodynamic calculations are presented that predict substantial enhancement of shock temperature and pressure in the explosive if the flyer plate overlaps the metal containment fixture at impact in the flying plate detonator configuration. The shock interactions of this geometry are discussed and guidelines are presented for utilizing this effect.

3788 (SAND—76-5732) **Modes of shock wave growth in the initiation of explosives.** Nunziato, J.W.; Kennedy, J.E.; Hardesty, D.R. (Sandia Labs., Albuquerque, N.Mex. (USA); Sandia Labs., Livermore, Calif. (USA)). 1976. Contract E(29-1)-789. 41p. (CONF-760805—20). Dep. NTIS $4.00.

From 6. symposium on detonation; San Diego, California, United States of America (USA) (24 Aug 1976).

The literature on shock initiation has carefully distinguished between the behavior of homogeneous and heterogeneous explosives with regard to reaction ignition, reaction growth, and the modes of wave growth. The paper illustrates the differences in shock growth modes in explosives representative of these two classes, nitromethane and PBX-9404, through the use of numerical calculations and previously reported experimental data. It then correlates the observed phenomena with some basic properties of the recently introduced concept of critical acceleration lambda for shock front growth, which is proportional to the reaction rate, and a new concept called the reaction communication distance, which is defined as the ratio of the sound speed to the reaction rate. This distance, which varies inversely with lambda, determines whether the energy released during the decomposition reaction becomes distributed throughout the shocked material or remains concentrated near the point of ignition. As a result, an explanation is provided for such distinctly different growth phenomena as superdetonation in homogeneous explosives and the strong pressure disturbance and growth at the front in heterogeneous explosives.

3789 (UCID—17173) **New concept in-line fuzing module.** Jaroska, M.F. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 22 Jun 1976. Contract W-7405-Eng-48. 21p. Dep. NTIS $3.50.

A new concept in-line fuzing module for the Air Force Hard Structure Munition Warhead is described. This new fuze design is made possible by the slapper detonator and the development of a new concept modular fuzing system intercommunication technique using the unique signal concept. The general safing, arming and firing systems are described with an emphasis placed upon the safety aspects of the fuze module.

3790 (UCRL—52000-76-7, pp 10-14) **Slapper: a new kind of detonator.** Stroud, J.R. Jul 1976.

In Energy and technology review.

The slapper detonator, a radical departure from conventional exploding bridgewire detonators, is one of the developments of LLL research into detonator design parameters. Called the slapper because it uses a high-velocity impact to initiate detonation in high-density explosives, it has applications in nonnuclear ordnance and, potentially, in commercial blasting. It is compact, inexpensive, easy to make, resistant to environmental extremes, and even safer than the conventional exploding bridgewire detonator.

NUCLEAR

REFER ALSO TO CITATION(S) 2642, 3817, 3850

CIVIL USES

REFER ALSO TO CITATION(S) 3842

3791 (NVO—174(Rev.1)) **Project Rulison well plugging and site abandonment plan.** (Energy Research and Development Administration, Las Vegas, Nev. (USA). Nevada Operations Office). Aug 1976. Contract E(26-1)-667. 51p. (PNE-R—67(Rev.1)). Dep. NTIS $4.50.

The plans and events involved in the well plugging, radiological sampling, decontamination, and site abandonment procedures for Project Rulison are described. (TFD)

WEAPONRY

3792 (SAND—76-8010) **B77 flight test data processing.** Humphrey, R.E.; Holbrook, E.D. (Sandia Labs., Livermore, Calif. (USA)). Jul 1976. Contract E(29-1)-789. 59p. Dep. NTIS $4.50.

A system of equations which can be used to obtain aerodynamic forces and moments, angles of attack and sideslip, and aerodynamic coefficients from flight test data obtained from the B77 Flight Test Program is presented.

3793 (UCRL—52000-76-7, pp 14-21) **Neutron and gamma-ray transport experiments in liquid air.** Farley, W.E. Jul 1976.

In Energy and technology review.

Accurate estimates of neutron and gamma radiations from a nuclear explosion and their subsequent transport through the atmosphere are vital to nuclear-weapon employment studies: i.e., for determining safety radii for aircraft crews, casualty and collateral-damage risk radii for tactical weapons, and the kill range from a high-yield defensive burst for a maneuvering reentry vehicle. Radiation transport codes, such as the Laboratory's TARTNP, are used to calculate neutron and gamma fluences. Experiments have been performed to check and update these codes. Recently, a 1.3-m-radius liquid-air (21 percent oxygen) sphere, with a pulsed source of 14-MeV neutrons at its center, was used to measure the fluence and spectra of emerging neutrons and secondary gamma rays. Comparison of measured radiation dose with TARTNP showed agreement within 10 percent.

ENVIRONMENTAL SCIENCES, ATMOSPHERIC

BASIC STUDIES

REFER ALSO TO CITATION(S) 3773

3794 (BNWL—2062) **Regional studies program workshop on air quality and meteorological assessments.** Renne, D.S. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Jun 1976. Contract E(45-1)-1830. 31p. Dep. NTIS $4.00.

A Regional Studies Program Workshop on Air Quality and Meteorological Assessments was held at the Battelle-Northwest Auditorium on March 9—10, 1976. Approximately twenty-three participants, including representatives from Battelle, Pacific Northwest Laboratory, Lawrence Livermore Laboratory, Los Alamos Scientific Laboratory, Argonne National Laboratory, Oak Ridge National Laboratory, Brookhaven National Laboratory, the Energy Research and Development Administration and a Washington State publicly owned utility, exchanged technical and philosophical views on their approach to performing assessments under the Regional Studies Program. Discussions included the technical approach under way at each laboratory, assessment objectives and techniques, and data needs and availability.

3795 (COO—2455-12) **Effect of a sinusoidal wave on diffusion from an infinite line source.** Kao, S.K.; Paegle, J.; Youngblood, R.D. (Utah Univ., Salt Lake City (USA). Dept. of Meteorology). Jan 1976. Contract ET(11-1)-2455. 25p. (CONF-761003—8). Dep. NTIS $3.50.

From Symposium on atmospheric turbulence, diffusion, and air quality; Raleigh, North Carolina, United States of America (USA) (19 Oct 1976).

An investigation of the effect of sinusoidal vertical motion on turbulent diffusion is made. The diffusion models analyzed are (1) without vertical motion, (2) with a simple sinusoidal vertical motion of constant amplitude, (3) with a sinusoidal vertical motion of damping amplitude. It is found from this investigation that the presence of undulations in vertical velocity has significantly enhanced the dispersion of pollution. Comparison of effective diffusivity shows an increase by a factor of 3.9 where no damping of undulations occurred, and by a factor of 2.8 where we have a damping of the undulations below the level of the source. This increase in dispersion can largely be explained by the fact that the undulations have created a dilution in concentration because of the vertical motion and a configuration in which horizontal diffusivity is allowed to have an effect in pulling pollutant away from the axis of maximum concentration. The damping of undulations below the level of the source serves to suppress this configuration which in turn reduces dispersion below the source, an obviously favorable antipollution configuration.

3796 (COO—2851-1) **Applicability of U.S. Army tracer test data to model validation needs of ERDA.** Shearer, D.L.; Minott,

D.H. (Research Corp. of New England, Wethersfield, Conn. (USA)). Jun 1976. Contract E(11-1)-2851. 73p. Dep. NTIS $4.50.

This report covers the first phase of an atmospheric dispersion model validation project sponsored by the Energy Research and Development Administration (ERDA). The project will employ dispersion data generated during an extensive series of field tracer experiments that were part of a meteorological research program which was conducted by the U. S. Army Dugway Proving Ground, Utah, from the late 1950's to the early 1970's. The tests were conducted at several locations in the U. S., South America, Germany, and Norway chosen to typify the effects of certain environmental factors on atmospheric dispersion. The purpose of the Phase I work of this project was to identify applicable portions of the Army data, obtain and review that data, and make recommendations for its uses for atmospheric dispersion model validations. This report presents key information in three formats. The first is a tabular listing of the Army dispersion test reports summarizing the test data contained in each report. This listing is presented in six separate tables with each tabular list representing a different topical area that is based on model validation requirements and the nature of the Army data base. The second format for presenting key information is a series of discussions of the Army test information assigned to each of the six topical areas. These discussions relate the extent and quality of the available data, as well as its prospective use for model validation. The third format is a series of synopses for each Army test report.

3797 (LA-UR—76-1068) **Atmospheric transport and dispersal at a site dominated by complex terrain.** Clements, W.E.; Barr, S. (Los Alamos Scientific Lab., N.Mex. (USA)). 1976. Contract W-7405-eng-48. 7p. (CONF-761003—7). Dep. NTIS $3.50.

From Symposium on atmospheric turbulence, diffusion, and air quality; Raleigh, North Carolina, United States of America (USA) (19 Oct 1976).

There is evidence that the stable nocturnal periods tend to amplify the terrain anomalies of particle transport and diffusion from the predictions of the traditional models. In an effort to identify phenomena which might create anomalous dispersion patterns, preliminary field work has been done in a typical canyon-mesa environment at Los Alamos, N.M. The early experiments focused on time and space variations of the dominant nocturnal drainage wind.

3798 (NYO—3425-12) **Measurement of airborne radioactivity and its meteorological application. Part V. Annual report, 1 April 1973—31 July 1974.** Reiter, R.; Kanter, H.J.; Sladkovic, R.; Poetzl, K. (Fraunhofer-Gesellschaft zur Foerderung der Angewandten Forschung e.V., Garmisch-Partenkirchen (Germany, F.R.). Inst. fuer Atmosphaerische Umweltforschung). Mar 1976. Contract E(11-1)-3425. 139p. Dep. NTIS $6.00.

Results are reported from studies on the exchange of air between stratosphere and troposphere. Continuous data on the concentrations of the radio-nuclides Be7, P32, P33, and S35, of the fallout and ozone from April 1972 to August 1974 are reported. The meteorological analysis of five intrusions of stratospheric air is presented.

3799 (TID—27098) **1975 operational report for METROMEX.** (Wyoming Univ., Laramie (USA)). Nov 1975. Contract E(11-1)-1199. 49p. Dep. NTIS $4.00.

Project METROMEX is a federation of research groups from several different institutions, applying their skills and facilities in a complementary and coordinated fashion to study inadvertent weather modification in the St. Louis Metropolitan area. Project METROMEX began operations in 1971 on a planned five years of field studies. Final reporting is anticipated by first quarter of 1977. The project has been supported by the State of Illinois and several Federal agencies. The calendar of operations during the 1975 summer season are set forth. Although planned for the immediate use of project scientists, it may subsequently be of value to others who may wish to relate their studies to METROMEX findings. For benefit of such persons a brief outline of project background is included in this introductory statement. Not covered are several theoretical, laboratory and numerical modeling efforts which are METROMEX-related but not directly involved in field observations.

3800 (UR—3490-966) **Annual report, University of Rochester Biomedical and Environmental Research Project: brief description of research papers accepted for publication during 1975.** Nash, D.B. (Rochester Univ., N.Y. (USA). Biomedical and Environmental Research Project). 25 Jun 1976. Contract E(11-1)-3490. 109p. Dep. NTIS $5.50.

Brief summaries are presented of papers accepted for publication during 1975 that report the results of research at the University of Rochester in the fields of biomedicine and environment. (CH)

3801 **Statistical hypothesis tests of some micrometeorological observations.** SethuRaman, S.; Tichler, J. (Brookhaven National Lab., Upton, NY). pp 183-187 of In Probability and statistics in atmospheric sciences. Boston; American Meteorological Society (1975).

From 4. conference on probability and statistics in atmospheric sciences; Tallahassee, FL, USA (18 Nov 1975).

Medium scales of turbulence up to a frequency of 0.5 hertz were tested for normality using the method of the chi-square goodness-of-fit test to 5 percent level of significance. Seventy percent of the data analysed were either normal or skewed normal after second approximation. Coefficient of skewness, g_1 was found to have a good correlation with the X^2 values. Sets of observations with $/g_1/$ exceeding 0.21 became approximately normal and passed chi-square test values up to 0.43. Coefficient of excess, g_2 for the data sets varied from -0.5 to 5.8 and did not have good correlation with the X^2 values. A tendency towards intermittency in turbulence was noted in the data that were not normal. Further analysis needs to be done to correlate the non-normality of the observations with the degree of intermittence. (auth)

3802 **Zonal and eddy forms of the available potential energy equations in pressure coordinates.** Boer, G.J. (Atmospheric Environment Service, Downsview, Ontario). *Tellus;* **27**: No. 5, 433-441(1975).

An approximation to the zonal and eddy forms of the available potential energy equations is developed from the exact equations in pressure coordinates. These equations preserve the form and symmetry of the exact equations to a large extent and reduce without approximation to the exact equations when the fields are purely zonal. The expressions for zonal and eddy available potential energy are applied to long-term atmospheric circulation statistics for the globe for the December—February season. The values of A/sub Z/ and A/sub E/ thus calculated differ somewhat from those obtained using Lorenz's approximate equations.

3803 **Secondary treatment information. Water programs.** *Fed. Regist. (Wash., D.C.);* **41**: No. 172, 37222-37223(2 Sep 1976). (40CFR133).

From Environmental Protection Agency.

The purpose of this proposal rulemaking is to amend the Secondary Treatment Information regulation (40 CFR, Part 133). The proposed amendment recognizes that properly designed and operated waste stabilization ponds are a form of secondary treatment which may not be capable of achieving the suspended solids limitations contained in 40 CFR 133 without supplemental treatment processes for the removal of suspended solids. Amendment of Secondary Treatment Information is proposed to allow upward adjustment of the suspended solids limitations in cases where ponds which have a design capacity of one million gallons per day or less are used as the process for secondary treatment.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 3313, 3796, 3799, 3814, 3815, 4007

3804 (BM-IC—8608) **Sulfur dioxide: its chemistry as related to methods for removing it from waste gases.** Haas, L.A. (Bureau of Mines, Twin Cities, Minn. (USA). Twin Cities Metallurgy Research Center). 1973. 22p. Bureau of Mines, Washington, DC.

The chemistry of current or potential SO_2 removal processes can be placed into four categories: (1) reduction, (2) liquefaction, (3) direct dissolution, and (4) oxidation. Methods that involve reducing SO_2 to elemental sulfur appear promising since this product can be easily handled, shipped, and stock-piled. Unfortunately, SO_2 cannot always be reduced directly when other oxidizing agents are present. Thermodynamic data indicate that some oxidizing reagents will also consume reductant at the reduction temperature. A two-stage process can be applied to waste gases that contain excessive quantities of oxygen, nitrogen oxides, and water vapor. The best sorbent for the first stage appears to be a nonalkali or nonalkaline earth medium since this medium more readily releases the SO_2 for reduction in the second stage.

3805 (BNL—21416) **Airborne measurements of aerosol and sulfate concentration discontinuities in vertical and horizontal profiles.** Brown, R.M.; Garber, R.W. (Brookhaven National Lab., Upton, N.Y. (USA)). 1976. Contract E(30-1)-16. 4p. (CONF-761003—14). Dep. NTIS $3.50.

From Symposium on atmospheric turbulence, diffusion, and air quality; Raleigh, North Carolina, United States of America (USA) (19 Oct 1976).

Airborne horizontal traverses were made in 1975 along a line from New York City to Washington, D.C. in attempts to observe and measure concentration changes in total particulates, particulate sulfate, and SO_x occurring downwind of several urban plumes along the flight path. Measurements were made when the wind flow was at right angle to the New York City—Washington, D.C. line (northwest or southeast). During these periods, flights parallel to the line pass through individual urban plumes and each can be studied as a separate case. Measurements were also made when the wind flow was parallel to the line (southwest or northeast). During these conditions, each urban industrial area contributes its individual share to one of the largest anthropogenic regional plumes known in which little distinction can be made from one urban plume to another. Furthermore, during periods of stagnating high pressure, which occur frequently along the east coast with southwesterly wind flows, some of the highest concentrations of particulates and sulfur compounds are found below the mixing level over large regional areas.

3806 (BNWL—1979(Rev.)) **Environmental surveillance at Hanford for CY-1975.** Speer, D.R.; Fix, J.J.; Blumer, P.J. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Jun 1976. Contract E(45-1)-1830. 82p. Dep. NTIS $5.00.

Environmental data collected during 1975 showed continued compliance of Hanford operations with all applicable state and federal regulations. Levels of radioactivity in the atmosphere from Hanford operations at all offsite sampling locations were indistinguishable from levels due to natural causes and worldwide fallout from the atmosphere. Air quality measurements of NO_x in the Hanford environs recorded a maximum yearly average concentration of 0.004 ppM or 8 percent of the ambient air standard. There was no indication that Hanford operations contributed significantly to these levels. All SO_x results were less than the detection limit of 0.005 ppM or 25 percent of the ambient air quality standard. Routine radiological, chemical, biological, and physical analyses of Columbia River water upstream and downstream of the Hanford Reservation did not show any identifiable effect due to Hanford operations with the possible exception of water temperature. Levels of radioactivity in biological samples are reported. (CH)

3807 (CONF-761003—2) **Deposition of SO_x on ground cover.** Murphy, B.D. (Oak Ridge National Lab., Tenn. (USA)). 1976. Contract W-7405-eng-26. 7p. Dep. NTIS $3.50.

From Symposium on atmospheric turbulence, diffusion, and air quality; Raleigh, North Carolina, United States of America (USA) (19 Oct 1976).

A method is outlined which calculates deposition velocity as the reciprocal of a resistance. This resistance, in turn, is a sum of three separately identifiable components: (a) an aerodynamic resistance, (b) a surface layer resistance, and (c) a surface-specific resistance reflecting the condition of the foliage which is considered to be the eventual sink for the material being deposited. Deposition of SO_x has been considered in illustrating the model. For a different gaseous material the same principles could apply. One should be aware, however, that the surface-specific resistance may vary when different gases are considered. The most obvious direction in which the model can be expanded is in the consideration of thermal stratification effects. Here we simply consider neutral conditions as applying "on the average" and use this approach as a first approximation when integrating aerodynamic and surface processes.

3808 (COO—2455-7) **Airborne air pollution monitoring experiment in an area of mountain-valley terrain.** Kao, S.K.; Taylor, G.H. (Utah Univ., Salt Lake City (USA)). Jan 1976. Contract ET(11-1)-2455. 69p. (CONF-761003—4). Dep. NTIS $4.50.

From Symposium on atmospheric turbulence, diffusion, and air quality; Raleigh, North Carolina, United States of America (USA) (19 Oct 1976).

An airborne monitoring program was conducted to determine the behavior of the plume emitted by a large copper smelter in northern Utah. Using a conductivity-type analyzer, sulfur dioxide concentrations were measured at various locations downwind of the source. A series of cross wind passes were flown, at incremental altitudes, to determine the concentration distribution of sulfur dioxide. Measured concentrations in the mountain-valley terrains were, in general, much lower than those predicted by the flat-surface diffusion model. It was felt that, since the smelter lies in an area of high relief, models intended for use over a flat surface would not be applicable for predicting plume concentrations in mountain-valley terrain; mechanical turbulence induced by mountain terrain near the source was thought to be the major cause of discrepancies between flat surface predictions and measured centerline concentrations. An analytic equation based on wind tunnel experiments was developed for use during southerly to easterly flow to predict lateral dispersion parameters within the plume. The approximations derived from this equation were a significant improvement over flat-terrain model predictions. The experiments suggest that the Gaussian diffusion model may be used for predicting pollution concentration in mountain-valley terrains with a modification of the dispersion parameters.

3809 (UCRL—78037) **NO/sub x/ catalytic ozone destruction: sensitivity to rate coefficients.** Duewer, W.H.; Wuebbles, D.J.; Ellsaesser, H.W.; Chang, J.S. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 27 Jul 1976. Contract W-7405-eng-48. 10p. (CONF-760833—1). Dep. NTIS $3.50.

From Symposium on atmospheric ozone/atmospheric chemistry and global pollution; Dresden, German Democratic Republic (9 Aug 1976).

An important observation is that the computed ambient concentrations from the various models were all in comparable agreement with observations. Some conclusions that can be drawn from this study include: Uncertainties in chemical rate coefficients can produce major uncertainties in ozone perturbations resulting from NO/sub x/ injections. Models predicting very different responses of ozone to NO/sub x/ injections can all be consistent with the observed stratospheric concentrations of minor species. Thus, there are clear limitations on the utility of stratospheric observations in estimating the reliability of models as predictive tools. The best way to reduce the uncertainty of model predictions will be to accurately measure uncertain rate coefficients.

3810 (UCRL—78092) **Satellite Ozone Analysis Center (SOAC).** Lovill, J.E.; Sullivan, T.J.; Knox, J.B.; Korver, J.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Aug 1976. Contract W-7405-eng-48. 17p. (CONF-760833—2). Dep. NTIS $3.50.

From Symposium on atmospheric ozone/atmospheric chemistry and global pollution; Dresden, German Democratic Republic (9 Aug 1976).

Many questions have been raised during the 1970's regarding the possible modification of the ozonosphere by aircraft operating in the stratosphere. Concern also has been expressed over the manner in which the ozonosphere may change in the future as a result of fluorocarbon releases. There are also other ways by which the ozonosphere may be significantly altered, both anthropogenic and natural. Very basic questions have been raised, bearing upon the amount of ozone which would be destroyed by the NO/sub x/ produced in atmospheric nuclear explosions. Studies of the available satellite data have suggested that the worldwide increase of ozone during the past decade, which was observed over land stations, may have been biased by a poor distribution of stations and/or a shift of the planetary wave. Additional satellite data will be required to resolve this issue. Proposals are presented for monitoring of the Earth's ozone variability from the present time into the 1980's to establish a baseline upon which regional, as well as global, ozone trends can be measured. (CH)

3811 **Feasibility of the $CaSO_4$—CaS reaction for regeneration of sulfated dolomite or limestone in sulfur dioxide pollution-control processes.** Hubble, B.R.; Siegel, S.; Cunningham, P.T. (Argonne National Lab., IL). *J. Air Pollut. Control Assoc.*; **25**: No. 12, 1256-1257(Dec 1975).

Possible regeneration mechanisms for sulfated dolomite or limestone are presented. Preliminary test results are encouraging, however, the actual reaction mechanism has not yet been established. It may involve gas-solid interactions as intermediate steps, with the overall process represented by the solid-solid reaction: $3CaSO_4 + CaS$ yields $4CaO + 4SO_2$. (ND)

3812 **Sulfur dioxide and material damage.** Gillette, D.G. (Environmental Protection Agency, Research Triangle Park, NC). *J. Air Pollut. Control Assoc.*; **25**: No. 12, 1238-1243(Dec 1975).

From 67. Annual meeting of Air Pollution Control Association; Denver, CO, USA (Jun 1974).

Whereas most estimates of material damage are based on industrial surveys, the estimates produced in this study were derived from material damage experiments and ambient air quality data. Air quality data on SO_x were obtained from 200 or more monitoring sites primarily located in heavily populated areas. Material threshold damage function data were then compared with SO_x levels, and an estimate of losses, as reflected in increased maintenance and replacement costs, was determined. Estimates of the total stock of various materials in use were derived from census and industry data and allocated geographically according to population. A substantial decrease in the ambient SO_x levels, particularly in larger urban areas, has occurred during the past five years. From 1968 to 1972, the estimated amount of material damage from SO_x in the U. S. decreased from $900 million/yr to less than $100 million. During this period, the estimated percentage of man-made materials exposed to SO_x levels exceeding the proposed secondary annual average standard (60 $\mu g/m^3$) and pri-

mary annual average standard (80 $\mu g/m^3$) in the U. S. fell, respectively, from 20 percent to less than 5 percent and from more than 10 percent to less than 1 percent. Most of the present loss is attributed to corrosion damage of metallic surfaces that are normally exposed to the ambient environment.

3813 Statistical aspects of the washout of polydisperse aerosols. Dana, M.; Hales, J.M. (Battelle Pacific Northwest Labs., Richland, WA). *Atmos. Environ.;* **10**: No. 1, 45-50(1976).

When considering the washout properties of polydisperse aerosols, one must specify whether the washout is in terms of number of aerosol particles, or in terms of length, area, or mass of aerosol. This follows from the fact that the effective washout coefficient is a function of the particle size distribution of the aerosol being removed. Sample calculations using collection efficiencies covering particle radii in the range 0.001 less than a less than 10 μm, and lognormal raindrop and particle size spectra show that the washout coefficient for a polydisperse aerosol is generally larger than it would be for a monodisperse aerosol of radius equal to some typically used distribution parameter. Thus, it is difficult, if not practically impossible, to deduce generalized washout properties of aerosols from experimental measurements involving polydisperse aerosols.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 2543, 2547, 3796, 3798, 3806, 3993, 3994

3814 (DPSPU—76-302) **Environmental monitoring at the Savannah River Plant. Annual report, 1975.** Ashley, C.; Zeigler, C.C. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). 1975. 84p. Dep. NTIS $5.00.

The environmental monitoring program at the Savannah River Plant (SRP) provides reliable measurement of radioactive materials both released at the source (approximately 40 locations) and concentrated in the environment (approximately 500 locations). In recent years, water quality testing and analysis have become an essential part of the environmental monitoring program. Aqueous discharges to plant streams are monitored for nonradioactive materials by chemical analyses of water sampled in flowing streams (approximately 25 locations). A brief discussion of plant releases to the environment and radioactive and nonradioactive materials detected in the environment are presented in the following text, figures, and tables. The appendices contain an interpretation of data treatment, tables of results of environmental sample analyses, sensitivities of laboratory analyses, and maps of sampling locations.

3815 (ORNL—5169) **Applied Health Physics and Safety annual report for 1975.** (Oak Ridge National Lab., Tenn. (USA)). Aug 1976. Contract W-7405-eng-26. 77p. Dep. NTIS $5.00.

This report describes and summarizes the activities of the applied sections and/or groups of the Health Physics Division. Projects and activities covered include personnel monitoring, environmental monitoring, radiation and safety surveys, and industrial safety. (CH)

3816 (SAND—76-8033) **Preoperational environmental monitoring report for the SLL Tritium Research Laboratory.** Devlin, T.K. (Sandia Labs., Albuquerque, N.Mex. (USA)). Jul 1976. Contract AT(29-1)-789. 13p. Dep. NTIS $3.50.

The Tritium Research Laboratory is designed to conform with the ERDA philosophy to keep tritium release as low as practicable. Though the main emphasis is on controlling tritium release at the source, an environmental monitoring program is maintained to ascertain the effectiveness of the control and containment measures and to determine whether any radiological changes in the environment are the result of TRL operations.

3817 (UCRL—52074) **Diffusion climatology for hypothetical accidents in area 410 of the Nevada Test Site.** Peterson, K.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 20 May 1976. Contract W-7405-eng-48. 46p. Dep. NTIS $4.00.

The regional climate around the Nevada Test Site (NTS) is described. Emphasis is placed on the wind direction and speed and the atmospheric stability in Area 410. Included are estimates of the fastest winds expected in tornadoes and severe thunderstorms. Three accident scenarios in Area 410 are covered: dispersal of 1 kg of ^{239}Pu from explosion of 68 kg (150 pounds) of high explosives; release of gross fission products from a 10^{19} fission accident resulting from inadvertent formation of a critical mass; and accidental detonation of a 100-ton fission primary. An Instantaneous Point Source (IPS) code was developed and is explained. The IPS code estimates concentrations in the surface air of radioactive particles that have negligible settling rates (have a radius less than 5 μm). For each accident, this code calculated and plotted contour maps that show the estimated exposures of the area to radioactive particles from the explosion.

3818 Guideline for monitoring the emission of radioactive substances in flue air from nuclear power stations with light-water cooled reactor (State: September 1975). *Umwelt (Inf. Bundesminist. Innern);* No. 44, 20-22(Nov 1975). (In German).

2 apps.

Specified requirements on sample taking and measuring methods as minimum requirements for monitoring are given.

3819 Atmospheric radioactivity data and the Weibull distribution function. Apt, K.E. (Los Alamos Scientific Lab., NM). *Trans. Am. Nucl. Soc.;* **23**: 87(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

THERMAL EFFLUENTS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 2665

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 3314, 3797, 3878

3820 (BNL—21601) **Study of the transport and diffusion climatology of the U.S. east coast.** Raynor, G.S.; Hayes, J.V. (Brookhaven National Lab., Upton, N.Y. (USA)). 1976. Contract E(30-1)-16. 4p. (CONF-760918—4). Dep. NTIS $3.50.

From Conference on coastal meteorology; Virginia Beach, Virginia, United States of America (USA) (21 Sep 1976).

This study is part of a larger investigation of coastal meteorology and diffusion. It is designed to describe and evaluate the transport and diffusion climatology of the entire U.S. east coast so that potential sites can be compared before selection. The data will also give guidance in planning for routine operation and possible accident situations after a site is chosen. Actual and proposed installations include both floating and shore-based nuclear power plants, fossil-fueled power plants, industries and refineries. Activities include oil drilling, fuel transport and movement of hazardous materials.

REGULATIONS

3821 (NP—21131) **Environmental impact statements: an analysis of six years' experience by seventy federal agencies.** (Council on Environmental Quality, Washington, D.C. (USA)). Mar 1976. 108p. Council on Environmental Quality, Washington, DC.

This report assesses federal implementation of the environmental impact statement requirement of the National Environmental Policy Act. The report asks how well the requirement fulfills its purpose of helping government officials reach informed decisions. It considers whether the content and quality of impact statements are adequate; whether complaints about delay from EIS procedures are justified; what purposes may be served by preparing impact statements on broad government programs or groups of projects; whether EIS review by state as well as federal agencies is working well or is in need of improvement; and whether public involvement in the whole process is satisfactory. It also examines some other special questions arising from the EIS requirement.

3822 Maintenance of national ambient air quality standards: summary. *Fed. Regist. (Wash., D.C.);* **41**: No. 86, 18382-18391(3 May 1976). (40CFR51).

From Protection of Environment, 40CFR51, Environmental Protection Agency—Preparation, adoption, and submittal of implementation plans.

The regulations pertain to the analysis and development of plans for air quality maintenance areas (AQMAs), required under 40 CFR 51.12. The regulations specify procedures to be used for estimating future air quality concentrations and for developing new control strategies necessary to ensure the maintenance of the national ambient air quality standards. They specify the approvable form and content of the analysis and State implementation plan revisions required in AQMAs.

3823 Revised heavy duty engine regulations for 1979 and later model years. *Fed. Regist.* (*Wash., D.C.*); **41**: No. 101, 21292-21313(24 May 1976). (40CFR86).

From Protection of Environment, 40CFR86, Environmental Protection Agency—Control of air pollution from new motor vehicles and new motor vehicle engines: certification and test procedures.

Standards are proposed beginning with the 1979 model year for both gasoline-fueled and Diesel heavy duty engines of 1.5 gms/BHP-hr. hydrocarbon (HC), 25 gms/BHP-hr. carbon monoxide (CO), and 10 gms/BHP-hr. hydrocarbon plus oxides of nitrogen (HC + NOx). Current standards are 16 gms/BHP-hr.HC + NOx and 40 gms/BHP-hr. CO without a separate HC requirement. Additionally, a Diesel engine peak smoke opacity standard of 35 percent instead of the present 50 percent standard is proposed to prevent degradation in on the road smoke levels as a result of changes in gaseous emissions standards. Nearly all currently certified engine families have demonstrated smoke levels at or below 35 percent peak opacity. Acceleration and lugging mode Diesel smoke standards of 20 and 15 percent are unchanged by the proposal. Test procedure revisions include the substitution of more accurate instrumentation for measurement of gasoline-fueled engine HC and both gasoline-fueled and Diesel NOx measurements; the addition of specific calibrations and maintenance procedures; and minor revisions to the test cycles.

3824 Proposed amendments to reference methods. *Fed. Regist.* (*Wash., D.C.*); **41**: No. 111, 23060-23090(8 Jun 1976). (40CFR60).

From Protection of Environment, 40CFR60, Environmental Protection Agency—Standards of performance for new stationary sources.

Reference methods are amended to clarify the methods to improve their accuracy and reliability as a result of continuing testing. References 1 through 8 as appended to Clean Air Act (39 FR 39872) are affected. Changes common to all eight of the reference methods are: (1) clarification of procedures and equipment specifications, and (2) the addition of metric units along with English units. (PCS)

3825 Nebraska: approval of plan revision and clarifying amendments. *Fed. Regist.* (*Wash., D.C.*); **41**: No. 122, 25898(23 Jun 1976). (40CFR52).

From Protection of Environment, 40CFR52, Environmental Protection Agency—Approval and promulgation of implementation plans.

Nebraska has adopted the second group of New Source Performance Standards promulgated by the EPA (39 FR 9308), in addition to the first group of five categories previously adopted. The seven categories of sources are: asphalt concrete plants; petroleum refineries; storage vessels for petroleum liquids; secondary lead smelters; secondary brass and bronze ingot production plants; iron and steel plants; and municipal sewage treatment plants.

3826 North Carolina: ambient SO_2 and NO_2 standards. *Fed. Regist.* (*Wash., D.C.*); **41**: No. 122, 25899(23 Jun 1976). (40CFR52).

From Protection and Environment, 40CFR52, Environmental Protection Agency—Approval and promulgation of implementation plans.

North Carolina, after notice and public hearing, has changed its annual and 24-hour SO_2 standards to make them equal to the national primary annual and 24-hour standards (80 and 365 $\mu g/m^3$, respectively). Also, the State has revoked its 24-hour ambient standard for nitrogen dioxide.

3827 Approval of revision to Maryland State implementation plan. *Fed. Regist.* (*Wash., D.C.*); **41**: No. 127, 26901-26902(30 Jun 1976). (40CFR52).

From Protection of Environment, 40CFR52, Environmental Protection Agency—Approval and promulgation of implementation plans.

The amendments submitted by Maryland cover gasoline handling vapor control. The regulations require Stage I vapor recovery equipment to be installed on all tanks with an average monthly throughput greater than 20,000 gallons based on a twelve month average.

3828 Revision to the New Jersey State implementation plan. *Fed. Regist.* (*Wash., D.C.*); **41**: No. 131, 27833-27834(7 Jul 1976). (40CFR52).

From Protection of Environment, 40CFR52, Environmental Protection Agency—Approval and promulgation of implementation plans.

Regulations for transfer of organic liquids including gasoline and the storage of volatile organic substances are presented for New Jersey with immediate effectiveness. (PCS)

3829 Revised guidelines for the implementation of the National Environmental Policy Act of 1969. *Fed. Regist.* (*Wash., D.C.*); **41**: No. 131, 27838-27843(7 Jul 1976).

From Transportation, 49CFR1100; 49CFR1108, Interstate Commerce Commission—Revised guidelines for implementation of the National Environmental Policy Act of 1969.

The Commission has adopted revised environmental rules which distinguish among the various classes of actions which come before the Commission, and identify (1) actions which have the potential for significant environmental impact and normally require an environmental impact statement, (2) actions which may have environmental issues present, but normally do not require an environmental impact statement, and (3) actions which normally have no environmental issues present. Detailed environmental information is required to be filed along with an application. The information required varies significantly according to which of the three above-described categories is applicable to a particular proceeding.

3830 New FPC Form No. 164. *Fed. Regist.* (*Wash., D.C.*); **41**: No. 146, 31340-31371(27 Jul 1976). (18CFR141).

From Conservation of Power and Water Resources, 18CFR141, Federal Power Commission—Financial report for municipal electric utilities and federal projects.

The proposed system will provide access to a central electronic data bank, eliminating the duplication of information now collected. The system will also accommodate the development of new regulatory techniques. (PCS)

3831 Supersonic aircraft. *Fed. Regist.* (*Wash., D.C.*); **41**: No. 159, 34722-34725(16 Aug 1976). (40CFR87).

From Protection of the Environment, 40CFR87, Environmental Protection Agency—Control of air pollution from aircraft and aircraft engines.

The final standards established herein fall within or above the range proposed for each pollutant and are levels which one of the manufacturers of the engines which power the Concorde, Rolls Royce Ltd., has testified could be met. The other manufacturer, SNECMA, testified that comparable emissions levels were achieveable (allowing for differences in measurement methodology) but that additional time should be permitted before compliance. Accordingly, the implementation date for the standards applicable to newly manufactured engines has been shifted from January 1, 1979, as proposed, to January 1, 1980. These standards are believed to be the most stringent that can be imposed by that date. They reflect the emission control technology currently under development and expected to be available to the SST engine manufacturers. The standards established here for newly certified SST engines reflect the best technology expected for subsonic engines, which is transferable to the T5 class. With regard to the oxides of nitrogen standard for newly certified engines, careful evaluation has led EPA to the conclusion that such a level is attainable without reliance upon water injection. Due to the time required to incorporate the necessary technology into T5 class engines, the date of implementation for the standards applicable to newly certified engines has been postponed to January 1, 1984.

3832 Ohio-sulfur dioxide plan. *Fed. Regist.* (*Wash., D.C.*); **41**: No. 168, 36324-36340(27 Aug 1976). (40CFR52).

From Protection of the Environment, 40CFR52, Environmental Protection Agency—Approval and promulgation of implementation plan.

Substitute sulfur dioxide control regulations designed to attain and maintain the ambient standards for sulfur dioxide in Ohio thereby correcting the deficiency in the Ohio Implementation Plan are presented. The maintenance portion of the plan is based on projected growth over the next ten years and the degree of control required of existing sources reflects the projected emission increase.

3833 Petroleum refinery fluid catalytic cracking. Unit catalyst regenerators. *Fed. Regist.* (*Wash., D.C.*); **41**: No. 169, 36600-36601(30 Aug 1976). (40CFR60).

From Protection of Environment, 40CFR60, Environmental Protection Agency—Standards of performance for new stationary sources.

Under the authority of section 111 of the Clean Air Act, as amended, the Administrator is proposing a revision to 40 CFR 60.102(a)(2), and 60.105(e)(1), opacity standard of performance for new, modified, and reconstructed petroleum refinery fluid catalytic cracking unit catalyst regenerators. The proposed revision would change the opacity standard from 30 percent, except for three minutes in any one hour, to 25 percent, except for two six-minute average opacity readings in any one hour. The revised standard would be neither more nor less stringent than the present standard, but would be consistent with the new provisions for determining the opacity of emissions.

3834 Pollutant Standards Index (OAQPS Number 1.2-0.44). Guideline for public reporting of daily air quality. *Fed. Regist. (Wash., D.C.);* **41**: No. 174, 37660-37671(7 Sep 1976).

From Environmental Protection Agency.

This guideline suggests the use of the Pollutant Standards Index (PSI) for those local and state air pollution control agencies wishing to report an air quality index on a daily basis. The PSI places maximum emphasis on protecting the public health; that is, it advises the public of any possible adverse health effects due to pollution. In order to err on the side of public safety, the index stresses reporting on the basis of the stations with the highest pollutant concentrations and assumes that other unsampled portions of the community will also experience high concentrations. In addition, its emphasis is upon acute health effects occurring over very short time periods (24 hours or less) rather than chronic effects occurring over months or years. It is not intended for, and should not be used for, ranking urban areas in terms of the severity of their air pollution problems. Such rankings require the use of many other kinds of environmental data not incorporated in this index. Finally, Appendix A discusses the meteorological information needs of forecasting relative index changes. This was prepared by personnel from the National Oceanic and Atmospheric Administration.

3835 Fuel economy testing for 1978 Model year automobiles and calculation procedures for 1977 and subsequent model year automobiles; exhaust emissions test procedures for 1978 Model year automobiles and light duty trucks. *Fed. Regist. (Wash., D.C.);* **41**: No. 177, 38674-38695(10 Sep 1976).

From Protection of Environment, 40CFR86; 40CFR600, Environmental Protection Agency—Control of air pollution from new motor vehicle engines: certification and test procedures. Fuel economy of motor vehicles.

These procedures provide means by which EPA will test automobiles and calculate an average fuel economy for each manufacturer's product line. In addition to fuel economy testing and calculation procedures, EPA is hereby promulgating and proposing changes to the test procedures used for measuring both exhaust emissions and city fuel economy for 1978 model year automobiles and light trucks. The changes are intended to improve the accuracy of the tests but not to affect their stringency. (PCS)

ENVIRONMENTAL SCIENCES, TERRESTRIAL

BASIC STUDIES

REFER ALSO TO CITATION(S) 2337, 2373, 3800

3836 (CONF-760703—4) **COMEX computer code: Monte Carlo analysis of ecosystem attributes.** Mankin, J.B.; Gardner, R.H.; Shugart, H.H. (Oak Ridge National Lab., Tenn. (USA)). 1976. 5p. Dep. NTIS $3.50.

From Summer computer simulation conference; Washington, District of Columbia, United States of America (USA) (12 Jul 1976).

COMEX is a computer program for Monte Carlo analysis of the effect of parameter perturbations on ecosystem models. The general method used is to perform successive simulations with a linear, stationary system with certain parameters chosen from a multivariate-normal sample of specified mean and variance. The results of simulations on two hypothetical terrestrial food chain models indicate that parameter values for these models must be measured with variability less than 20 percent if meaningful model predictions are expected. The application of this technique will allow quantitative comparison of many ecosystem models.

3837 Soil nutrient content of old-field and agricultural ecosystems exposed to chronic gamma irradiation. Armentano, T.V.; Holt, B.R.; Bottino, P.J. (Brookhaven National Lab., Upton, N.Y. (USA)). *Radiat. Bot.;* **15**: No. 4, 329-336(Dec 1975).

Soil nutrients (extractable P. and NO_3-N, exchangeable Ca, Mg and K), exchangeable Al, pH and organic matter content were measured over the top six inches of the soils of the seven-year old-field portion and the cultivated portion of the Brookhaven gamma field. Although concentrations of all nutrient elements were higher in the agricultural soil, the distributions of Ca, P, Al, pH and organic matter were similar along the radiation gradient in both fields. There was also a regular reduction in the phosphorus with decreasing exposure, but distribution of other elements was not clearly related to radiation effects. The distribution of all elements except K was significantly correlated with pH in the agricultural soil. In the old-field only Ca, Mg and Al showed this relationship. The most conspicuous effects of nearly 25 yr of chronic irradiation of the site were a reduction in soil organic matter content and an increase in soil P in both fields.

RADIOMETRIC TECHNIQUES

REFER ALSO TO CITATION(S) 3847

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 3815

3838 (CONF-741122—(Absts.)) **Conference on intoxication due to alkylmercury treated seed, Baghdad, Iraq, 9—13 November 1974. Final report. Abstracts.** (World Health Organization, Geneva (Switzerland)). 1974. 46p. World Health Organization, Geneva, Switzerland.

From Conference on intoxication due to alkyl mercury treated seed; Baghdad, Iraq (9 Nov 1974).

Some topics discussed are as follows: problems related to the chemical treatment of seed; flameless atomic absorption estimation of mercury; chemical types of mercury in patients; tissue levels in organomercury poisoning; psychiatric aspects of methylmercury poisoning; heavy metal resistance in bacteria; mercury in hair as indicator of total body burden; extracorporeal regional complexation dialysis in patient with mercury poisoning; erythrocyte survival studies and hematological assessment; differential effects of mercurial compounds on excitable tissues; brain mercury concentrations in relation to dose; effects of dimercaptosuccinic acid and D-penicillamine on mercury retention in rats following a dose of mercury bichloride and methylmercuribromide; mercury in foodstuffs; absorption, distribution, and metabolism of organomercury in sheep; and prenatal methylmercury poisoning. (HLW)

3839 (ORNL-tr—4126) **Contamination of soil, agricultural crops, and vegetables by 3,4-benzpyrene in the vicinity of Ceske Budejovice.** Kolar, L.; Ledvina, R.; Ticha, J.; Hanus, F. Translated by S.D. Blalock Jr. from *Cesk. Hyg.;* **20**: No. 3, 135-139(1975). 7p. Dep. NTIS $3.50.

In the soils and plants of the area of Ceske Budejovice, the carcinogenic 3,4-benzo(a)pyrene was found. The amount of the carcinogen was inversely proportional to the distance of sampling point from industrial and town sources of exhalations. The concentrations of 3,4-benzo(a)pyrene in the soil were in the range 8.3 to 42.1 μg/kg, in the grain 0.2 to 7.5 μg/kg, in vegetables 0.1 to 24.3 μg/kg and in fruit 0.2 to 29.7 μg/kg. The part of plants above surface of earth proved to contain higher amount of the carbohydrate than the underground part. The pollution proved to be proportional to the time of exposure during the vegetation period and to the surface of the plant material. Washing of the fruit and vegetables by cold water did not virtually decrease the content of 3,4-benzo(a)pyrene.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 2543, 3814, 3815, 3816

3840 (BNWL—1703) **Variable thickness transient groundwater flow model theory and numerical implementation.** Kipp, K.L.; Reisenauer, A.E.; Cole, C.R.; Bryan, C.A. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1976. Contract E(45-1)-2130. 57p. Dep. NTIS $4.50.

Modeling of radionuclide movement in the groundwater system beneath the Hanford Reservation requires mathematical simulation of the two-dimensional flow in the unconfined aquifer. This was accomplished using the nonlinear, transient Boussinesq equation with appropriate initial and boundary conditions, including measured Columbia River stages and rates of wastewater disposal to the ground. The heterogeneous permeability (hydraulic conductivity) distribution was derived by solution of the Boussinesq equation along instantaneous streamtubes of flow employing a measured water table surface and a limited number of field-measured hydraulic conductivity values. Use of a successive line over-relaxation technique with unequal time steps resulted in a more rapid convergence of the numerical solution than with previous techniques. The model was used to simulate the water table changes for the period 1968 through 1973 using known inputs and boundary conditions. A comparison of calculated and measured water table elevations was made at specific well locations and the quality of the verification simulation was evaluated using a data

retrieval and display system. Agreement between the model results and measured data was good over two-thirds of the Hanford Reservation. The capability of the model to simulate flow with time-varying boundary conditions, complex boundary shapes, and a heterogeneous distribution of aquifer properties was demonstrated.

3841 (COO—1156-83) **Plutonium in a grassland ecosystem.** Little, C.A. (Colorado State Univ., Fort Collins (USA). Dept. of Radiology and Radiation Biology). Aug 1976. Contract E(11-1)-1156. 206p. Dep. NTIS $7.75.

Thesis.

A study was made of plutonium contamination of grassland at the Rocky Flats plant northwest of Denver, Colorado. Of interest were: the definition of major plutonium-containing ecosystem compartments; the relative amounts in those compartments; how those values related to studies done in other geographical areas; whether or not the predominant isotopes, ^{238}Pu and ^{239}Pu, behaved differently; and what mechanisms might have allowed for the observed patterns of contamination. Samples of soil, litter, vegetation, arthropods, and small mammals were collected for Pu analysis and mass determination from each of two macroplots. Small aliquots (5 g or less) were analyzed by a rapid liquid scintillation technique and by alpha spectrometry. Of the compartments sampled, greater than 99 percent of the total plutonium was contained in the soil and the concentrations were significantly inversely correlated with distance from the contamination source, depth of the sample, and particle size of the sieved soil samples. The soil data suggested that the distribution of contamination largely resulted from physical transport processes.

3842 (NVO—269-27) **Amchitka radiobiological program progress report, January 1975—December 1975.** Nelson, V.A.; Seymour, A.H. (Washington Univ., Seattle (USA)). May 1976. Contract E(26-1)-269. 52p. Dep. NTIS $4.50.

Begun in 1970, the Amchitka Radiobiological Program is a continuing program to collect biological and environmental samples for radiometric analyses. This report is an account of the program for Calendar Year 1975. Results of analyses for samples collected in August 1975 have been added to the tables that summarize the results of analyses of samples collected from 1970 to 1975 and include analyses for gamma-emitting radionuclides in air filters, freshwater, birds, lichens, marine algae, marine invertebrates, fish, aufwuchs, and freshwater moss and plants; strontium-90 (^{90}Sr) in rats, birds, and soil; $^{239,240}Pu$ in sand, soil, marine algae and fish; and tritium (^{3}H) in seawater, freshwater, and biological organisms. Monitoring of background radiation with survey instruments was added to the Laboratory's program in 1974 and the results of the 1974 and 1975 surveys are included in this report. It is concluded from the results of analyses of samples collected between September 1969 and August 1975 as reported in this and the five previous progress reports, that there were no radionuclides of Milrow or Cannikin origin in the water, plants, or animals of Amchitka Island.

3843 (UCLA—12-1055) **Estimated inventory of plutonium and uranium radionuclides for vegetation in aged fallout areas.** Romney, E.M.; Gilbert, R.O.; Wallace, A.; Kinnear, J. (California Univ., Los Angeles (USA). Lab. of Nuclear Medicine and Radiation Biology). Feb 1976. Contract E(14-1)-GEN-12. 25p. Dep. NTIS $3.50.

Data are presented on the contamination of vegetation by ^{239}Pu, ^{240}Pu, and other radionuclides in aged fallout areas on the Nevada Test Site (NTS) and the Tonopah Test Range (TTR). Comparisons of soil and vegetation inventory estimates indicate that the standing vegetation contributes an insignificant portion of the total amount of $^{239-240}Pu$ present in these aged fallout areas. The amounts of Pu available for vegetation-transport to animals grazing on-site would appear to be relatively small in comparison to the total amounts deposited upon soil. Findings indicate that most of the contaminant found on vegetation probably is attributable to resuspendable materials. (CH)

3844 (UCLA—12-1056) **Plant uptake of ^{239}Pu, ^{240}Pu and ^{241}Am through roots from soils containing aged fallout materials.** Romney, E.M.; Wallace, A.; Wieland, P.A.T.; Kinnear, J.E. (California Univ., Los Angeles (USA). Lab. of Nuclear Medicine and Radiation Biology). Feb 1976. Contract E(04-1)-GEN-12. 19p. Dep. NTIS $3.50.

Several species of plants were grown under glasshouse conditions in pot cultures containing soil from some of the aged plutonium fallout areas on the Nevada Test Site (NTS) and the Tonopah Test Range (TTR). This interim report contains results for alfalfa, barley, and soybean plants from experiments designed to test the influence of soil amendments on plant uptake of $^{239-240}Pu$ and ^{241}Am through live root systems. Growth conditions were such that foliage surface contamination could be prevented with confidence.

SOIL

REFER ALSO TO CITATION(S) 2544

TERRESTRIAL ECOSYSTEMS AND FOOD CHAINS

REFER ALSO TO CITATION(S) 3806, 3841, 3843, 3844

3845 (BNL—21729) **Peridinin-chlorophyll a proteins of dinoflagellate algae.** Siegelman, H.W.; Kycia, J.H.; Haxo, F.T. (Brookhaven National Lab., Upton, N.Y. (USA)). 1976. Contract E(30-1)-16. 17p. Dep. NTIS $3.50.

The pigments which function as the energy collection systems for photosynthesis are either tetrapyrroles or carotenoids. In the oceans, which cover over 70 percent of the surface of the earth, carotenoids may be more important than chlorophylls for photosynthetic energy capture by phytoplankton. A characteristic feature of the principal marine phytoplankton is the possession of a high carotenoid content. In general each major group of phytoplankton has a specific carotenoid which accounts for a major portion of the total carotenoid content. The peridinin-chlorophyll a proteins from dinoflagellates examined were found to exist in a unique and distinctive pattern as shown by isoelectric focusing on polyacrylamide gel. These patterns may be of value for species identification and provide a biochemical marker for a particular species. To date, no similar proteins have been isolated from other phytoplankton groups.

3846 (COO—1156-82) **Besnoitiosis in rodents from Colorado.** Dagle, G.E.; Winsor, T.F.; Adee, R.R. (Colorado State Univ., Fort Collins (USA). Dept. of Radiology and Radiation Biology). [nd]. Contract E(11-1)-1156. 4p. Dep. NTIS $3.50.

Parasitic cysts of Besnoitia jellisoni (coccidia) were found in rodents (Peromyscus maniculatus and Spermophilus tridecemlineatus) trapped in Eastern Colorado. The parasite was associated with a granulomatous inflammatory reaction in the lungs of each rodent and was disseminated in several organs from one Peromyscus. The ultrastructural appearance of the merozoites and the cyst wall formed by the host cell were studied.

3847 (COO—1332-123) **Vertebrate behavior and ecology. Progress report, July 1, 1975—June 30, 1976.** Tester, J.R.; Siniff, D.B. (Minnesota Univ., Minneapolis (USA)). Jul 1976. Contract E(11-1)-1332. 64p. Dep. NTIS $4.50.

Progress is reported on the development of statistical procedures and quantitative methods for analysis of ecological and wild animal behavioral data; coexistence and population dynamics of selected vertebrates with emphasis on the grey fox (Sciurus carolinensis) and red squirrel (Tamisciurus hudsonicus); application of radio telemetry to selected problems in vertebrate censusing and population study; fish response to alterations in water quality resulting from power production; and seasonal migrations and habitat selection of the pronghorn antelope (Antilocapra americana). (CH)

3848 (SRO—641-23) **Oribatid mites and nutrient cycling.** Crossley, D.A. Jr. (Georgia Univ., Athens (USA). Dept. of Entomology). Aug 1976. Contract E(38-1)-641. 16p. Dep. NTIS $3.50.

Communities of oribatid mites (Cryptostigmata) in leaf litter and forest soils consist of an impressive number of individuals. Total populations of the order of 10^5 oribatids per square meter are commonly reported from forest floors. Because of their numbers, oribatids have been believed to be important contributors to the breakdown of organic detritus. Results are reported from studies of mineral or nutrient element cycling in forest floor ecosystems using radioisotopes as tracers. The phenomenon of cycling allows for the study of feedback loops among ecosystem processes, whereas energy flow is unidirectional. Evaluation of feedback loops can be a means of quantifying indirect effects of consumers. The availability of radioactive isotopes or radioactive analogs of mineral elements allows for the direct measurement of transfer rates. In decomposition studies applications of radioactive tracers have helped to identify pathways of transfer from microflora to oribatids.

3849 (ERDA-tr—161) **[Ecology of the jer-falcon].** Portenko, L.A. 1970. Translation of Hierofalco gryfalco grebnitzii sev.: the krechet (jer-falcon). 5p. Dep. NTIS $3.50.

Nesting habits, range, and seasonal variations in color of the krechet (jer-falcon, hawk) on St. Laurentiy Island and the Chukotsk Peninsula in northeast USSR near the Bering Sea are described. Observations since 1881 are reported. (CH)

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 2336, 3316, 3840, 3878

3850 (NVO—409-3) **Nonradiation effects on natural vegetation from the Almendro underground nuclear detonation.** Tueller, P.T; Clark, J.E. (Nevada Univ., Reno (USA)). Mar 1976. Contract AT(26-1)-409. 33p. Dep. NTIS $4.00.

Nonradiation effects on the natural vegetation, primarily pinyon/juniper woodland, in the vicinity of project Almendro have been studied. Evaluation of tree and shrub damage along two radiating transects indicated that numerous trees were damaged or killed. Most of the damage obvious during the summer of detonation occurred from falling rock. Fresh rock movements were noted in flat areas and especially along cliffs. At 10,000 ft from surface zero, damage occurred primarily because of the incidence of cliffs in the plot areas. At 500 ft from surface zero: 38 percent of the pinyon trees and 29 percent of the juniper trees were found dead after detonation based on data from a single one-fifth acre plot. However, of the other nine stations that were studied by aerial photography, there was no pinyon nor juniper mortality found at six of them although each station was farther from surface zero. Water potential measurements in big sagebrush were apparently unaffected by detonation or secondary effects. Soil moisture depletion rates showed no significant alterations near surface zero. Phenology of major species was not disrupted. Year-to-year phenology differences were greater than within year changes that might have resulted from ground motion damage. Clipping of individual shrubs before and after detonation revealed no reduction in productivity. Juniper is slightly more susceptible to damage from ground motion than pinyon. Tree damage, while common along the igneous cliffs, does not seem excessive when considering the entire area.

3851 (PRNC—202) **Radionuclide content of soils from Barrio Islote, Arecibo, Puerto Rico.** Block, A.McB.; Clements, R.G. (Puerto Rico Nuclear Center, San Juan). Jun 1976. Contract E(40-1)-1833. 251p. Dep. NTIS $9.00.

The purpose of this report is to present and interpret gamma ray energy spectra from natural radioactivity and fallout radionuclides measured on soil samples collected in the projected thermonuclear power plant exclusion zone in Barrio Islote, Puerto Rico. (CH)

3852 (UCID—17205-1) **LWR fuel cycle quarterly report, April 1—June 30, 1976.** Dickerson, M.H.; Ng, Y.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jul 1976. Contract W-7405-Eng-48. 11p. Dep. NTIS $3.50.

A detailed agricultural data base for the Savannah River Plant and its environs was begun. This data base will contain information and data such as crop production, growing season, soil type, and agricultural practices that are needed to assess foodchain pathways. It will be used in the initial assessment of environmental effects of the LWR Fuel Recycle Complex at the Savannah River site.

REGULATIONS

REFER ALSO TO CITATION(S) 3821, 3829

ENVIRONMENTAL SCIENCES, AQUATIC

BASIC STUDIES

REFER ALSO TO CITATION(S) 2335, 3800, 3860

3853 (BNL—20882) **Controllable real-time data collection system for coastal oceanography.** Dimmler, D.G.; Huszagh, D.W.; Rankowitz, S.; Scott, J. (Brookhaven National Lab., Upton, N.Y. (USA)). 1976. Contract AT(30-1)-16. 14p. (CONF-760908—1). Dep. NTIS $3.50.

From Ocean 76 symposium; Washington, District of Columbia, United States of America (USA) (13 Sep 1976).

A real-time data acquisition and control system for coastal oceanography was developed. The system is designed for the measurement of low-frequency phenomena at numerous physically remote and unattended stations and consists of a mobile central command station, a telemetry subsystem operating two dedicated VHF channels and a set of remote stations. All manual interactions are accomplished at an on-shore central station through a general purpose computer which also controls automatic measuring sequences.

3854 (CONF-7505119—1) **Ecology of running waters; theory and practice.** Cummins, K.W. (Michigan State Univ., Hickory Corners (USA). W.K. Kellogg Biological Station). 1975. Contract E(11-1)-2002. 18p. Dep. NTIS $3.50.

From Sandusky river basin symposium; Tiffin, Ohio, United States of America (USA) (2 May 1975).

Studies are evaluating the extrapolation of lotic theory based on first to third order streams to larger (higher order) running waters. Of particular interest is the utilization of information on ecological structural properties and functional relationships of non-perturbated systems in the development of management strategies.

3855 (RLO—2225-T25-14) **Physical oceanography and sediment transport on the continental shelf of Washington. Report of progress, October 1974—September 1975.** Smith, J.D.; Hickey, B.; Beck, J.R. (comps.). (Washington Univ., Seattle (USA). Dept. of Oceanography). 30 Jun 1975. Contract AT(45-1)-2225-TA25. 35p. Dep. NTIS $4.00.

The effort was divided between work on the outer and central continental shelf and work on the inner continental shelf. On the central and outer shelf both cross-shelf (in preparation) and longshelf (in press) variation in currents in the summer season were studied and a field program designed to investigate both cross-shelf and longshelf current structure and the baroclinic response of shelf water to the wind during the winter season was implemented. In regard to the inner shelf, efforts were concentrated on the fabrication and testing of a Self-contained Underwater Data System (SUDS) capable of measuring currents in the nearshore environment.

3856 (RLO—2227-T12-55) **Review of the deep water Liparidae from the coast of Oregon and adjacent waters.** Stein, D.L. (Oregon State Univ., Corvallis (USA)). Jun 1976. Contract AT(45-1)-2227. 202p. Dep. NTIS $7.75.

Thesis.

A study of newly available liparid material from bathyal and abyssal depths off Oregon and adjacent waters is presented. The identification of known species, description of new species, and provision of keys for the identification of all species presently or likely to be found below 200 m in the study area are discussed.

3857 **Angiosperm production of three Virginia marshes in various salinity and soil nutrient regimes.** Mendelssohn, I.A.; Marcellus, K.L. (Virginia Inst. of Marine Science, Gloucester Point). *Chesapeake Sci.*; 17: No. 1, 15-23(Mar 1976).

The net aerial angiosperm productivity, salinity, and soil nutrient composition of three Virginia marshes were determined. Oligohaline Ware Creek Marsh and mesohaline Carter Creek Marsh were most productive, 563 and 572 g $m^{-2}yr^{-1}$, respectively, while euhaline Wachapreague Marsh was least productive, 362 g $m^{-2}yr^{-1}$. Species in Carter and Ware Creek Marshes were clustered into associations based on salinity tolerance. Nitrogen and phosphorus concentrations of Spartina alterniflora tissue were high in the spring and decreased as the growing season continued. Soil nutrient concentrations were variable, and trends during the growing season were not discernible. No significant correlations were found between soil and plant nutrient concentrations. Although the empirical data suggests that high soil salinity and low soil nitrogen and phosphorus concentrations limited primary productivity in Wachapreague Marsh, a multiple regression of standing crop on there parameters did not delineate any as the primary factor limiting salt marsh production.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 2374, 3586, 3814, 3815, 3870

3858 (CONF-750646—2) **Use of macroinvertebrate benthos in evaluating environmental damage.** Cummins, K.W. (Michigan State Univ., Hickory Corners (USA). W.K. Kellogg Biological Station). 1976. Contract E(11-1)-2002. 11p. Dep. NTIS $3.50.

From Workshop on the biological significance of environmental impacts; Ann Arbor, Michigan, USA (4 Jun 1975).

The categorization of running-water macroinvertebrates into functional groups based on their nutritional source and behavioral and morphological adaptations of food gathering is discussed. The importance of the functional groups as processors of organic matter, detritus, and in-stream primary production is the basis of their usefulness as indicators of environmental damage. Changes in

the relative dominance of macroinvertebrate functional groups reflect alterations in the balance between the inputs of particulate organic matter of terrestrial origin, including the particle size distribution of such detritus, and aquatic primary production (attached algae and rooted vascular plants).

3859 (COO—3254-32) **Effects of environmental stress on the community structure and productivity of salt marsh epiphytic communities. Progress report, September 1, 1975—August 31, 1976.** Lee, J.J. (City Coll., New York (USA)). 1976. Contract E(11-1)-3254. 200p. Dep. NTIS $7.50.

The importance of food quality (strength of food web bonds) was shown in a study of seasonal switching in a harpacticoid copepod. Unlike the evidence obtained for some planktonic species, size of algal food was not an important factor in the feeding of Nitocra typica. The animal has nutritional requirements which seem to adapt it to feed on different species and strains of algae which are likely to occur in the community at different seasons. The results of this study suggest complexions in trophic dynamics which explain some of the diversity inherent in the closely packed niches of micro- and meiofauna in detrital food webs. An in situ incubation subproject aimed at testing the effects of water quality, heavy metals, and crude oil on natural assemblages of diatoms was also completed. Since the experimental communities were confined and recruitment could not take place, changes in the diatom assemblages were due to their biotic interactions within the context of the ambient environmental fluxes. Though the initial populations of transplanted diatom assemblages were quite dissimilar, convergent changes took place in the assemblage trajectories during summer succession. Comparisons of the trajectories of the metallic ion and crude oil enriched assemblages brought out similarities of patterns. The best correlation in succession trajectories was between oil and Pb (approximately 75 percent). Iron enrichment favored the development of a community quite different from controls or other experimentals. Recurrent group analysis of the diatom flora gave insight into species selected by the experimental conditions.

3860 (RLO—2225-T40-1) **Hydrocarbon studies in Puget Sound and off the Washington coast. Report of progress, June 1975—February 1976.** Carpenter, R.; Fairhall, A.W. (comps.). (Washington Univ., Seattle (USA). Dept. of Oceanography). Feb 1976. Contract AT(45-1)-2225-T40. 27p. Dep. NTIS $4.00.

This progress report summarizes the results of our first eight months of research on the aliphatic and aromatic hydrocarbons in organisms, sediments and waters of Puget Sound and the Washington shelf north of the Columbia River. We are determining the types and amounts of aliphatic and aromatic hydrocarbons by applying the techniques of gas chromatography, high pressure liquid chromatography, UV fluorescence spectroscopy, combined gas chromatography-mass spectrometry, and ^{14}C and $^{13}C/^{12}C$ determinations.

3861 (RLO—2227-T12-50) **Metals in estuaries.** Cutshall, N.H. (Oregon State Univ., Corvallis (USA). School of Oceanography). 1974. Contract AT(45-1)-2227. 7p. (CONF-740385—1). Dep. NTIS $3.50.

From 3. annual technical conference on estuaries; Corvallis, Oregon, United States of America (USA) (14 Mar 1974).

A review of data on metal pollution in estuarine systems showed that metals appear to undergo reactions in estuaries. Whether these reactions are toward increased or lessened solubility may depend upon the specific metal and estuary. Seasonal variations are possible. Changes in physical form can be expected to affect the transport routes and rates of metals in the coastal zone and their persistence in estuaries. Changes in both physical and chemical form influence the biological significance of metals because toxicity and assimilation efficiency both depend heavily upon chemical form.

3862 (SREL—6) **Annual report of ecological research at the Savannah River Ecology Laboratory.** (Savannah River Ecology Lab., Aiken, S.C. (USA)). May 1976. Contract E(38-1)-819. 95p. Dep. NTIS $5.00.

Studies on mineral cycling are concerned with availability of stable elements and radionuclides to the biota of the southeastern coastal plain; the role of primary producers, consumers, and detritivores in cycling processes; the factors that limit or regulate rate processes in southeastern ecosystems; the importance of interactions among energy flow, thermal environments, and mineral cycling processes on rates of biomass buildup and transfer within southeastern ecosystems; the extent to which transfer coefficients are modified by population processes that influence the temporal or spatial turnover of compartmental standing crops; and the validation of models of cycling processes in southeastern ecosystems at various sites on the southeastern coastal plain. Research in thermal ecology is being conducted on macrophytes, snails, fishes, high parasites, shrimp, crayfish, turtles, and alligators. (HLW)

3863 (SRO—777-1(Pts.1-3)) **Studies on the effects and the accumulation of mercury on phytoplankton of Par Pond, Savannah River Plant, Aiken, South Carolina. Final report.** Zingmark, R.G.; Knowles, S.C.; Miller, T.G. (South Carolina Univ., Columbia (USA). Dept. of Biology). Mar 1975. Contract AT(38-1)-777. 76p. Dep. NTIS $6.00.

Studies on the synergistic effects of mercury and temperature on the phytoplankton of Par Pond showed that there was a synergistic effect on production when the organisms were shocked with warm or cold water. When the phytoplankton were transferred from cold to hot, production increased without mercury, while the phytoplankton exposed to mercury were inhibited. Other studies were conducted on the uptake and accumulation rates of mercury at various mercury concentrations; results are shown by means of graphs. Studies were conducted to determine the effects of $HgCl_2$ on the photosynthetic rates of phytoplankton and the growth and reproductive rates of selected cultured species of phytoplankton as influenced by the concentration of the mercury in the media, the concentration of cells and stage of the growth cycle upon exposure to the mercury, and the duration of exposure to mercury. Organisms used were the dinoflagellate, Amphidinium carterae, and the diatom, Skeletonema costatum. The effects of mercury and temperature interactions on the growth of phytoplankton were studied using three species of algae. Synura petersenii was severely inhibited by mercury in all experiments. When Chlamydomonas sp. was subjected to mercury at 30°, growth was severely inhibited. Growth of Nitzschia sp. was enhanced at 15° when temperature shock was followed by mercury addition. (HLW)

3864 (UNC-SG—75-04) **Legal measures concerning marine pollution.** Wurfel, S.W. (ed.). (North Carolina State Univ., Raleigh (USA)). Feb 1975. 83p. North Carolina State Univ., Raleigh $2.00.

It is proposed that the oceans be treated as international rivers for purposes of evaluating the rights and obligations of states regarding pollution of the seas. A survey of the issues shows that the fundamental elements of a workable system of pollution control are present in this proposal. Legal problems of marine pollution in relation to artificial islands are discussed and the need for new international law is emphasized. Other topics discussed are: fourth amendment problems in the enforcement of marine conservation laws; intentional ocean dumping of industrial chemical waste; and the quest for oil; a decisive force in the law of the Arctic Sea pertaining to pollution. (HLW)

3865 (ORNL-tr—4191(DRAFT)) **Mechanisms of natural and forced degradation of carcinogenic and toxic pollutants discharged into water bodies.** Gubergrits, M. Translated by M. Gerrard from *Vodn. Resur.*; 3: 185-188(1975). 4p. Dep. NTIS $3.50.

Generalizations in the field of degradation of carcinogenic polycyclic aromatic hydrocarbons (PAU), in particular their typical example 3,4-benzopyrene (BP) are presented. These processes which occur under conditions of water reservoirs as a result of the action of a number of physicochemical and/or biological agents are examined within the framework of solution of two problems—internal and external. Among the first of these are the process of degradation of BP dissolved in organic liquids or pollution carriers (petroleum products from processing of liquid and solid fuels, etc.), which form a solid film on the surface of the water or somewhat homogeneous inclusions in its depths. Among the external problems we examine the conversion of BP dissolved directly in the water.

3866 **Uptake and release of phosphorus by phytoplankton in the Chesapeake Bay estuary, USA.** Taft, J.L.; Taylor, W.R.; McCarthy, J.J. (Johns Hopkins Univ., Baltimore). *Mar. Biol.*; 33: No. 1, 21-32(10 Nov 1975).

The phytoplankton uptake and release rates for inorganic phosphate, dissolved organic phosphate and polyphosphate were estimated during 5 cruises on the Chesapeake Bay over a 9-month period. Phosphorus in all pools turned over in several minutes to 100 h, and each soluble pool appeared to contain fractions which were metabolically useful to the phytoplankton. Maximal uptake rates for orthophosphate ranged from 0.02 to 2.95 μg-at. P $(l.h)^{-1}$ with half saturation constants between 0.09 and 1.72 μg-at. P/l. At low soluble reactive phosphorus concentrations, the uptake rate of trace ^{32}P orthophosphate was initially rapid, but declined after 15 to 60 min incubation. The data suggest that the initial uptake phase was dominated by exchange of $^{32}PO_4^{-3}$ for $^{31}PO_4^{-3}$ in the membrane transport systems whereas the subsequent phase represented the net incorporation of orthophosphate into phytoplankton cells.

3867 **Phosphorus distribution in the Chesapeake Bay.** Taft, J.L.; Taylor, W.R. (Johns Hopkins Univ., Baltimore). *Chesapeake Sci.*; 17: No. 2, 67-73(Jun 1976).

The phosphorus distribution in the open waters of the Chesapeake Bay is described. Maxima of soluble reactive phosphorus (SRP) in deep water and total phosphorus in the euphotic zone occur in late summer. The maximum of SRP occurs concurrently with both the seasonal high in productivity in the surface waters and the seasonal depletion of dissolved oxygen in the deep water. It is suggested that, at this season, phosphate that is produced by remineralization of organic matter escapes precipitation as the ferric salt due to the anoxic conditions and is vertically transported into the euphotic zone where it is rapidly converted into particulate phosphorus by algae. Trophic condition with respect to phosphorus in the open Bay near Annapolis appears to have been unchanged during the period 1938 to 1973.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 3806, 3814, 3815, 3816, 3840, 3842, 3851, 3862

3868 (COO—3563-36) **Americium in the marine environment-relationships to plutonium.** Livingston, H.D.; Bowen, V.T. (Woods Hole Oceanographic Institution, Mass. (USA)). 1976. Contract AT(11-1)-3563. 22p. (CONF-750672—2). Dep. NTIS $3.50.

From 8. international conference on environmental toxicology; Rochester, New York, USA (2 Jun 1975).

The behavior of ^{241}Am in the marine environment, and by analogy other transplutonium nuclides, is compared and contrasted with that of $^{239,240}Pu$. Radiochemical data for these nuclides in seawater, sediments, and organisms contaminated mostly by global fallout, are used to generate the ratio $^{241}Am/^{239,240}Pu$. It is used as an index of fractionation between Pu and Am. The average value for this ratio (0.20) found in shallow nearshore sediments is proposed as representative by mid-73 of integrated, unfractionated fallout at mid-latitudes in the Northern Hemisphere. No fractionation between Am and Pu has been found in these sediments even under conditions when they are being lost from the sediment following upward vertical migration. Higher ratios in deep ocean water and sediments suggest that Am sinks more quickly than Pu in the water column. Data for some marine organisms, mostly algae, suggest that while Am may frequently be concentrated to a degree similar to that for Pu, some organisms may discriminate against, others in favor of, Am relative to Pu.

3869 (RLO—2225-T18-18) **Biogeochemistry of radionuclides in aquatic environments. Annual progress report, 1975—1976.** Schell, W.R. (Washington Univ., Seattle (USA). Lab. of Radiation Ecology). 15 Jan 1976. Contract E(45-1)-2225-T18. 54p. Dep. NTIS $4.50.

The present work is a combination of studies on natural radionuclides ^{210}Po and ^{210}Pb in aquatic environments and on the biogeochemistry of the transuranium elements ^{239}Pu, ^{240}Pu, and ^{241}Am, in the Bikini Lagoon. The objectives of the biogeochemical studies are to evaluate the cycling of the radionuclides in the aquatic environment from their sources, their distribution within ecosystems, their uptake by biota, and their sinks. Detailed studies of the conditions which now exist some 17 years since the last nuclear detonations at Bikini should give a basis for predicting the effects of large-scale or low-level continuous releases of nuclear waste products in the marine environment.

AQUATIC ECOSYSTEMS AND FOOD CHAINS

REFER ALSO TO CITATION(S) 3847, 3861, 3868, 3869

3870 (ORNL/TM—4978) **Submodels: COPEPOD population parameters as functions of environmental factors.** Maguire, L.A.; Blum, S.R.; Gehrs, C.W.; Van Winkle, W. (Oak Ridge National Lab., Tenn. (USA)). Jul 1976. Contract W-7405-eng-26. 61p. Dep. NTIS $4.50.

This report describes a set of function submodels that have been developed to calculate copepod population parameters (e.g., clutch size, mortality) as functions of environmental factors (e.g., water temperature, food). Since little is known about how environmental conditions influence copepod population parameters, a variety of functional forms that can be used to relate any population parameter to any environmental factor have been constructed. A brief review of the literature on the calanoid copepod Diaptomus clavipes Schacht and related species suggests functions that may be appropriate for specific biological relationships. This report describes how to select an appropriate function, estimate its parameters, and interpret the results of model simulations.

THERMAL EFFLUENTS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 2665, 3073, 3085, 3086, 3087

3871 (COO—2502-5) **Thermoregulation and temperature relations of alligators and other large ectotherms inhabiting thermally stressed habitats. Annual progress report, July 1, 1975—June 30, 1976.** Spotila, J.R. (State Univ. of New York, Buffalo (USA). Dept. of Biology). Mar 1976. Contract E(11-1)-2502. 18p. Dep. NTIS $3.50.

The effects of radiation and convection on the equilibrium body temperatures of alligators have been determined. Gaping has been shown to be an effective thermoregulatory device for retarding heat gain in the heads of these animals. Initial time dependent experiments have been completed and ketamine hydrochloride has been shown to be an effective anesthetic for alligators. Evaporative water loss rates have been measured as a function of size, temperature and wind speed for the turtle Chrysemys scripta. Convection coefficients have been determined and climate spaces are being formulated. Field studies are under way at the Savannah River Ecology Laboratory. Convection coefficients for largemouth bass, Micropterus salmoides change as a function of temperature and water speed. Steady state heat energy budgets have been computed for this fish. The effects of arsenic and temperature on the temperature tolerance of larval muskellunge, Esox masquinongy, have been determined. The thermal tolerances of several species of minnows have also been measured. The role of the skin in the control of evaporation from amphibians and reptiles has been assessed. During the past year one article has been published, two are in press, one is in review, and eight are in preparation. Five masters theses will be completed by July 1976.

3872 (EPRI—11) **Environmental responses to thermal discharges from Marshall Steam Station, Lake Norman, North Carolina.** Jensen, L.D. (Johns Hopkins Univ., Baltimore, Md. (USA). Dept. of Geography and Environmental Engineering). Apr 1974. 248p. Electric Power Research Institute, Palo Alto, CA $8.00.

For Electric Power Research Institute, Palo Alto, CA and Duke Power Co.

Studies of thermal effects of the cooling water discharge of Duke Power Company's Marshall Steam Station on Lake Norman in North Carolina were initiated in July 1965. Work during the first 3 years involved the collection of physical and meteorological data for use in evaluating the thermal behavior of the lake and in developing temperature prediction techniques for similar deep, thermally stratified lakes. In 1968 the research was expanded to include biological studies of thermal effects. Since that time, the program has collected data from 18 stations on Lake Norman in the vicinity of the Marshall Steam Station, pertaining to water temperatures, various meteorological and water quality parameters, and populations of fish, plankton, and benthic invertebrates. The biological data have involved population and diversity studies in the main body of the lake, as well as in the intake and discharge coves. Studies on the effects of entrainment of planktonic organisms, and their passage through the condenser system of the power station, have also been conducted.

3873 (EPRI—12) **Environmental responses to thermal discharges from the Indian River Station, Indian River, Delaware. Research project RP-49.** Jensen, L.D. (Johns Hopkins Univ., Baltimore, Md. (USA). Dept. of Geography and Environmental Engineering). Nov 1974. 216p. Electric Power Research Inst., Palo Alto, CA.

For Electric Power Research Institute and Delmarva Power and Light Co.

Studies relative to the environmental effects of the Indian River Power Station of the Delmarva Power and Light Company on the Indian River estuary were initiated in 1966 as a result of interest on the part of the Delmarva Power and Light Company in collection of biological field data from the Indian River Power Station. In 1967 the studies were added to the Edison Electric Institute Cooling Water Research Project (RP-49) of The Johns Hopkins University. The studies have involved a detailed examination of water quality and nutrients in addition to temperature in the Indian River estuary. Fisheries data were collected in the Indian River to study the normal distribution of adult and juvenile fishes of both resident and migratory species as well as the distribution relative to the thermal discharges from the Indian River Power Station. Studies on the species composition and distribution

benthic invertebrates have also been conducted in the vicinity of the Indian River Power Station. Planktonic investigations have involved population and diversity studies in the estuary, and have been augmented by entrainment studies of the effect of passing microscopic organisms through the condenser system of the power station.

3874 (EPRI—13) **Environmental responses to thermal discharges from the Chesterfield Station, James River, Virginia. Research project RP-49.** Jensen, L.D. (Johns Hopkins Univ., Baltimore, Md. (USA). Dept. of Geography and Environmental Engineering). Dec 1974. 191p. Electric Power Research Inst., Palo Alto, CA.

For Electric Power Research Institute and Virginia Electric and Power Co.

Studies relative to the environmental effects of the Chesterfield Power Station of the Virginia Electric and Power Company on the tidal James River were initiated early in the spring of 1968 as a result of interest on the part of the Virginia Electric and Power Company in collection of biological field data from the Chesterfield Power Station. In 1969 the studies were added to the Edison Electric Institute Cooling Water Research Project (RP-49) of The Johns Hopkins University. The studies have involved a detailed examination of over 25 water quality parameters in addition to temperature and dissolved oxygen in the James River for more than 25 sampling stations, starting above the city of Richmond, Virginia, and extending at times to Hopewell, Virginia, a distance of approximately 27 km. Fisheries data have been collected from the same stations and have included studies on adult and juvenile fishes on both resident and transient species. Studies on the benthic invertebrates have also been conducted in the vicinity of the Chesterfield Power Station. Planktonic investigations have involved population and diversity studies in the main river as well as Farrar Gut, and have been augmented by entrainment studies of the effect of passing microscopic organisms through the condenser system of the power station.

3875 (KFK—2195) **First semiannual report, 1975.** (Kernforschungszentrum Karlsruhe (Germany, F.R.). Projekt Nukleare Sicherheit). Sep 1975. vp. (In German). INIS.

Other papers are covered by separate abstracts. (ERB)

3876 (KFK—2195, pp 136-140) **Investigations of the heat exchange River/atmosphere at the Rhine river downstream of the Philippsburg nuclear power plant.** Hoffmann, G.; Sauter, H.; Schikarski, W. Sep 1975. (In German).

1 fig.

In First semiannual report, 1975.

The control of the movement of the floating components of the mechanical construction above the river Rhine had been working insufficiently from the beginning. The friction between the column and the floating mast was reduced to avoid excessive damping of vertical motion due to changes in water height. Additionally, a special installation was provided in order to obtain a suitable support for lifting the pontoon sheares in case of iceflow. In the course of the repairs several cables were damaged and had to be renewed as well as several on-line amplifiers. Regarding the data gathering complex, there was a considerable delay in programming the processor code. This was due to hardware breakdowns of tape reader, memory driver and CAMAC Analog-Digital-Converters. As to the ADCs, the manufacturer finally worked out some alternations in the circuit to achieve a sufficient reliability in the recycling mode operation. The improvements have been suitable for software test purposes but the ADCs are not yet satisfactory for permanent automatic operation.

3877 (SRO—869-1) **Response of estuarine fish embryos to environmental temperature shock. Annual progress report, January 14, 1975—January 13, 1976.** Dean, J.M. (South Carolina Univ., Columbia (USA)). 1 Apr 1976. Contract AT(38-1)-869. 29p. Dep. NTIS $4.00.

The results have demonstrated that the most sensitive stages to acute thermal shock were the 1-2 and 2-4 cell stages of periods of cell division. Late embryos and larvae were more tolerant of temperature and chemical stress than were juveniles or adults. The level and duration of exposure was not critical at less than 40°C for 24°C acclimated fish. Increased incubation temperatures shortened the time to hatching and fish reared at high but non-lethal temperatures had higher feeding rates than those reared below an apparently sensitive environmental level of 24°C. The results of the exposure of different developmental stages to chlorine and temperature at different levels and for different durations are still undergoing analysis. Preliminary interpretation is possible of the 0 and 7 day larvae stage where the effects were obvious but more subtle interaction effects could occur at earlier developmental stages and not be apparent without the further statistical analysis that is underway.

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 2336, 3070

3878 (CONF-760656—1) **Regional analysis and environmental impact assessment.** Parzyck, D.C.; Brocksen, R.W.; Emanuel, W.R. (Oak Ridge National Lab., Tenn. (USA)). 1976. Contract W-7405-Eng-26. 25p. Dep. NTIS $3.50.

From Symposium on biological evaluation of environmental impact; New Orleans, Louisiana, United States of America (USA) (2 Jun 1976).

This paper presents a number of techniques that can be used to assess environmental impacts on a regional scale. Regional methodologies have been developed which examine impacts upon aquatic and terrestrial biota in regions through consideration of changes in land use, land cover, air quality, water resource use, and water quality. Techniques used to assess long-range atmospheric transport, water resources, effects on sensitive forest and animal species, and impacts on man are presented in this paper, along with an optimization approach which serves to integrate the analytical techniques in an overall assessment framework. A brief review of the research approach and certain modeling techniques used within one regional studies program is provided. While it is not an all inclusive report on regional analyses, it does present an illustration of the types of analyses that can be performed on a regional scale.

REGULATIONS

REFER ALSO TO CITATION(S) 3821, 3829

3879 (LBL—5317) **Oil and hazardous substances pollution contingency plan.** Young, J. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jun 1976. Contract W-7405-eng-48. 12p. Dep. NTIS $3.50.

LBL policy and procedures are given for implementing the federal water pollution policy (FWPCA 311(b)(1)) that forbids discharge of oil or hazardous substance into or upon navigable waters of the U.S. Design, surveillance and clean-up procedures are given for both on-site and off-site spills. Oil spills from electric power transformers are treated separately. (PCS)

3880 **Proposed toxic pollutant effluent standards.** *Fed. Regist. (Wash., D.C.);* **41**: No. 113, 23576-23596(10 Jun 1976). (40CFR129).

From Protection of the Environment, 40CFR129, Environmental Protection Agency—Water program.

The proposed regulations would establish effluent standards for all manufacturers and formulators of any of the following four toxic pollutants who discharge directly into the navigable waters: aldrin/dieldrin, DDT (DDE, DDD), endrin and toxaphene. Standards are established for both existing sources and new sources. Manufacturers and formulators who discharge into publicly owned treatment works, as defined in section 212 of the Federal Water Pollution Control Act, are not covered by the standards herein proposed. However, the Agency expects to propose pretreatment standards for such indirect dischargers pursuant to the authority contained in section 307 of the Act in due course.

3881 **Application of permit program to agricultural activities.** *Fed. Regist. (Wash., D.C.);* **41**: No. 134, 28493-28497(12 Jul 1976).

From Protection of Environment, 40CFR124; 40CFR125, Environmental Protection Agency—State program elements necessary for participation in the National Pollutant Discharge Elimination System. National pollutant discharge elimination system.

These regulations clarify EPA's NPDES jurisdiction over discharges of pollutants from agricultural activities by defining which sources of pollutants are point sources, and thus subject to the NPDES permit program. It has been determined that, because of the reasons explained below, point sources in the agricultural activities category are conveyances from which irrigation return flow is discharged as a result of the controlled application of water by any person. These point sources will be subject to the general permit program to be proposed shortly in the Federal Register. It is anticipated that under this general permit program few owners or operators will be required to submit applications or other information to the permit-issuing authority. In addition, few owners or operators will be required to monitor, inventory, sample, record, submit reports, install pollution control devices, or otherwise change their method of operation. However, it must be emphasized that these regulations are not intended to supersede or supplant existing State regulations for control of pollution from agriculture,

and that owners and operators affected by State regulations remain subject to such regulations. Also, as section 208 plans are developed and implemented, pollution control requirements may be necessary where these plans identify solutions to substantial water quality problems.

ENVIRONMENTAL-SOCIAL ASPECTS OF ENERGY TECHNOLOGIES

REFER ALSO TO CITATION(S) 3794

SOCIAL AND ECONOMIC STUDIES

REFER ALSO TO CITATION(S) 3071, 3311, 3333, 3346

BIOMEDICAL SCIENCES, BASIC STUDIES

REFER ALSO TO CITATION(S) 3800

3882 (CONF-761007—2) **Biomedical Computing Technology Information Center (BCTIC) sharing program, data, and interface design.** Maskewitz, B.F.; Henne, R.L.; McClain, W.J. (Oak Ridge National Lab., Tenn. (USA)). 1976. Contract W-7405-ENG-26. 10p. Dep. NTIS $3.50.

From Conference on productivity through instrumentation and control; Houston, Texas, United States of America (USA) (10 Oct 1976).

In response to a recognized need to facilitate computing technology transfer in biomedicine, the Biomedical Computing Technology Information Center (BCTIC) was established by the Division of Biomedical and Environmental Research (DBER) of the U.S. Energy Research and Development Administration (ERDA) at the Oak Ridge National Laboratory in July of 1975. This paper presents the problems BCTIC has set out to solve, describes its functions, and categorically relates its functions to the stated problems. It also gives a progress report on BCTIC's developmental phase, and takes a look to the future of BCTIC as a national technology resource in biomedical computing.

BEHAVIORAL BIOLOGY

REFER ALSO TO CITATION(S) 3847, 4010

3883 (COO—1332-122) **Factors affecting home range of mallard pairs.** Riechmann, J.H. (Minnesota Univ., Minneapolis (USA)). Jun 1976. Contract E(11-1)-1332. 30p. Dep. NTIS $4.00.

Thesis.

Certain habitat and social factors were investigated for their effect on home range size of mallard (Anas platyhynchos) pairs breeding in a forested region of north-central Minnesota during the spring of 1971—72. Data from 31 radio-marked hens and drakes were used, but primary emphasis was placed on 8 pairs (5 with both members of the pair marked). Pairs were radio-tracked on river marsh areas, river channels, and large sand lakes to provide comparative data for evaluating home range size differences. Home ranges varied from an average of 53 ha for pairs using primarily river habitat to 871 ha for pairs using only large sand lakes. River and lake shorelines varied considerably in species and density of vegetation. Interaction between pairs as well as density of flocked males appeared to be influenced by these habitat differences with resultant effects on home range sizes.

3884 **Migratory orientation by marbled salamanders (Ambystoma opacum) near a breeding area.** Shoop, C.R.; Doty, T.L. (Univ. of Rhode Island, Kingston). *Behav. Biol.*; **7**: No. 1, 131-136(Feb 1972).

Marbled salamanders (Ambystoma opacum) exhibited oriented movements when migrating to and from breeding areas. The directional precision of these movements was affected only slightly by length of time spent in the breeding area, size (age), and sex of migrating individuals, and actual directions of travel. New methods of presenting orientation data are incorporated. (auth)

BIOCHEMISTRY

REFER ALSO TO CITATION(S) 2285, 3911, 3912, 3913, 3915, 3918, 3921, 3927, 3942, 4003, 4008, 4011

3885 (BNL—21358) **T7 and T3 as a model system for RNA synthesis and processing.** Dunn, J.J.; Anderson, C.W.; Atkins, J.F.; Bartelt, D.C.; Crockett, W.C. (Brookhaven National Lab., Upton, N.Y. (USA)). 1976. Contract E(30-1)-16. 11p. (CONF-760456—1). Dep. NTIS $3.50.

From Symposium on RNA(the relation of structure to function; Gatlinburg, Tennessee, United States of America (USA) (5 Apr 1976).

Some topics discussed are as follows: properties of RNase; degrading of double-stranded RNA to acid soluble fragments by endonuclease; purification of RNase III; fidelity of RNase III cleavage in vitro; effects of monovalent salt concentration on cleavage; effect of cleavage on translation; and effects of adding increasing amounts of T_3 mRNA and a saturating amount of brome mosaic virus RNA on synthesis of T_3 proteins. (HLW)

3886 (COO—3225-24) **Enzymatic studies of radiation damage. Progress report.** Laskowski, M. Sr. (Health Research, Inc., Albany, N.Y. (USA); New York State Dept. of Health, Albany (USA)). 1976. Contract E(11-1)-3225. 10p. Dep. NTIS $3.50.

A review on nucleolytic enzymes is expected to appear this month. Three abstracts were sent, two to Federation and one to the International Society on Toxicology. Further improvements were made in the method of preparation of venom exonuclease (phosphodiesterase). Other enzymes in venom hydrolyzing phosphate bonds were also partially purified. The major progress was made in the understanding of action of mung bean nuclease. Two papers not mentioned in publications were submitted to the Journal of Biological Chemistry and will be included in next year's report. The enzyme protein was characterized and the mechanism of action on native DNA was studied. Conditions were found to produce large (about 1 million dalton) duplex fragments from native T_7 DNA. Under different conditions, these fragments are degraded from their ends with the production of mono- to trinucleotides.

3887 **Occurrence and characteristics of ^{18}O exchange reactions catalyzed by sodium- and potassium-dependent adenosine triphosphates.** Dahms, A.S.; Boyer, P.D. *J. Biol. Chem.*; **248**: No. 9, 3155-3162(10 May 1973).

Microsomal preparations of the Na^+, K^+-ATPase from the porcine kidney outer medulla and the Electrophorus electroplax catalyzed a rapid Mg^{2+}- and K^+-dependent exchange of water oxygens with inorganic phosphate in the absence of ATP or ADP. Exchange activity was unaffected by uncouplers and inhibitors of oxidative phosphorylation but was inhibited by Na^+, ouabain, N,N'-dicyclohexylcarbodiimide, or p-mercuribenzoate. No nucleotide requirement for the exchange could be demonstrated. Addition of ATP to a Na^+-inhibited system resulted in an exchange of oxygens of medium P/sub i/ concomitant with ATP hydrolysis. This ATP-induced exchange amounted to 1.5 oxygen atoms per P/sub i/ released. Neither ADP nor adenyl methylenediphosphonate would serve to activate the exchange. Treatment of the preparations with deoxycholate apparently uncoupled the medium P/sub i/ reversible HOH exchange but was without affect on the ATP-induced exchange. The data suggest that the exchange arises by dynamic reversal of a late step in ATP hydrolysis by the Na^+, K^+-ATPase. (auth)

3888 **Repeated DNA sequences in fungi.** Dutta, S.K. (Howard Univ., Washington, DC). *Nucleic Acids Res.*; **1**: No. 11, 1411-1420(Nov 1974).

Several fungal species, representatives of all broad groups like basidiomycetes, ascomycetes and phycomycetes, were examined for the nature of repeated DNA sequences by DNA:DNA reassociation studies using hydroxyapatite chromatography. All of the fungal species tested contained 10 to 20 percent repeated DNA sequences. There are approximately 100 to 110 copies of repeated DNA sequences of approximately 4 x 10^7 daltons piece size of each. Repeated DNA sequence homoduplexes showed on average 5°C difference of T/sub e/50 (temperature at which 50 percent duplexes dissociate) values from the corresponding homoduplexes of unfractionated whole DNA. It is suggested that a part of repetitive sequences in fungi constitutes mitochondrial DNA and a part of it constitutes nuclear DNA. (auth)

3889 **Comparative base compositions of chloroplast and cytoplasmic tRNA/sup Phe/'s from Euglena gracilis.** Hecker, L.I.; Uziel, M.; Barnett, W.E. (Oak Ridge National Lab., TN). *Nucleic Acids Res.*; **3**: No. 2, 371-380(Feb 1976).

The nucleoside compositions of chloroplast and cytoplasmic tRNA/sup Phe/'s from Euglena gracilis have been determined. The modified nucleoside compositions of these two tRNAs indicate that tRNA/sub Chl//sup Phe/ is more similar to procaryotic (E. coli) tRNA/sup Phe/ than to either the Euglena cytoplasmic tRNA/sup Phe/ or other eucaryotic cytoplasmic tRNA/sup Phe/'s. (auth)

3890 Kinetic study of the action of snake venom phospholipase A_2 on human serum high density lipoprotein 3. Pattnaik, N.M.; Kezdy, F.J.; Scanu, A.M. (Univ. of Chicago). *J. Biol. Chem.*; **251**: No. 7, 1984-1990(10 Apr 1976).

The hydrolysis of the phospholipids of intact human serum high density lipoprotein 3 (HDL_3) by pure α-phospholipase A_2 from Crotalus adamanteus was studied by pH-stat titration. The enzyme quantitatively hydrolyzed phosphatidylcholine and phosphatidylethanolamine and left sphingomyelin intact, yielding a stable and water-soluble modified HDL. Lysophospholipids and free fatty acids, the products of hydrolysis, remained in the lipoprotein. When 1 mol of defatted bovine serum albumin/mol of substrate phospholipids was added to the reaction mixture, up to 60 percent of the fatty acids and 85 percent of the lysophospholipids were removed from the modified lipoprotein. The immunological reactivity of the hydrolyzed HDL remained unaltered in both the presence and absence of albumin. The changes in the physical properties of the lipoprotein during hydrolysis were rather small, the most notable being an increase in the hydrated density and in the electrophoretic mobility in alkaline buffers. From the accessibility of the HDL phospholipids to phospholipase A_2 one concludes that the phosphatidylcholine and phosphatidylethanolamine are located at, or are in rapid equilibrium with, the surface of this lipoprotein. It also appears that these phospholipids are not essential for maintaining the supramolecular properties of the lipoprotein in vitro. Thus the study of the modified HDL should provide valuable information concerning the structure and function of this lipoprotein particularly with regard to the role played by sphingomyelin.

3891 Modification of the Shandon Southern apparatus MK II for SDS preparative polyacrylamide gel electrophoresis. Ryan, T.E.; Woods, G.M.; Kirkpatrick, F.H.; Shamoo, A.E. (Univ. of Rochester, NY). *Anal. Biochem.*; **72**: No. 1/2, 359-365(7 May 1976).

The Shandon Southern preparative polyacrylamide gel electrophoresis apparatus was modified to permit use with SDS (sodium dodecyl sulfate) containing systems. Improvements include the elimination of the troublesome lower gel and modification of the elution plate to prevent localized high current densities and band overlapping. Separations were performed on the two subunits of Electrophorus electroplax $Na^+ + K^+$-ATPase, the erythrocyte membrane protein Spectrin, and the tryptic fragments of rabbit white skeletal muscle $Ca^{2+} + Mg^{2+}$ - ATPase.

3892 Increasing the flexibility of polyacrylamide gel-slab isoelectric focusing. Feinstein, R.N. (Argonne National Lab., IL). *Anal. Biochem.*; **72**: No. 1/2, 533-538(7 May 1976).

The flexibility and usefulness of polyacrylamide gel-slab isoelectric focusing is greatly increased by performing separations with glass slides embedded in the gel. After separation, each gel-coated slide can be treated separately; as many as eight individual reactions can be observed after a single electrofocusing or electrophoresis run. Other modifications described include the simultaneous electrofocusing of two different gel compositions and a simple technique for permanent recording which does not require photography.

3893 Gel-holding device for use with a guillotine-type gel slicer. Fisher, W.D.; Stallions, D.R. (Oak Ridge National Lab., TN). *Anal. Biochem.*; **72**: No. 1/2, 658-660(7 May 1976).

Various methods have been proposed for sectioning polyacrylamide disc gels. A modification of the McIlwain tissue chopper is commercially available (Brinkman Instruments, Inc., Westbury, New York). Following the method of Loening, the manufacturer recommends the use of Dry Ice to attach the frozen gel cylinder to the slicing platform of the device. In our experience the technique is tedious and requires constant monitoring to maintain the gel at the correct temperature for slicing. This report describes a simple, efficient, and inexpensive device for attaching unfrozen polyacrylamide gel cylinders to the platform of the guillotine-type gel slicer.

3894 Guidelines. Recombinant DNA research. *Fed. Regist. (Wash., D.C.)*; **41**: No. 131, 27902-27940(7 Jul 1976).

From Department of Health, Education, and Welfare.

An environmental impact assessment of these guidelines for recombinant DNA research in accordance with the National Environmental Policy Act of 1969 is announced. The NIH Guidelines establish carefully controlled conditions for the conduct of experiments involving the production of such molecules and their insertion into organisms such as bacteria. These Guidelines replace the recommendations contained in the 1975 Summary Statement of the Asilomar Conference on Recombinant DNA Molecules. The latter would have permitted research under less strict conditions than the NIH Guidelines.

3895 Conformational properties of dinucleoside monophosphates in solution: dipurines and dipyrimidines. Lee, C.H.; Ezra, F.S.; Kondo, N.S.; Sarma, R.H.; Danyluk, S.S. (State Univ. of New York, Albany). *Biochemistry*; **15**: No. 16, 3627-3639(10 Aug 1976).

Complete, accurate sets of nuclear magnetic resonance (NMR) parameters were derived for each nucleotidyl unit by simulation-iteration methods. A complete set of chemical shift and coupling constant data was also obtained for all the constituent monomeric units at a concentration and ionization state comparable to that of the dimers. Conformational properties were evaluated quantitatively for most of the bonds in the dinucleoside monophosphates using procedures developed in earlier studies. The data are in accord with the existence of extended conformations in equilibrium with two folded structures, a compact base-stacked right helical structure and a loosely base-stacked loop structure characteristic of a left helical form. It is suggested that the O3′-P-O5′ frame is highly flexible and acts as the swivel enabling the 3′- and 5′-nucleotidyl units to stack-destack depending on the nature of the π-ring system in the bases and solvent and temperature conditions. Stacking will cause a modest decrease in chi/sub CN/ with an accompanying increase in C_3′-endo populations, the latter in turn shifting the 3′ phosphate group from g^+ to g^- domains. In short we envision a coupled series of conformational events at the onset of stacking made feasible by the swivel nature of the O3′-P-O5′ bridge.

3896 Evidence for more than one Ca^{2+} transport mechanism in mitochondria. Puskin, J.S.; Gunter, T.E.; Gunter, K.K.; Russell, P.R. (Univ. of Rochester, NY). *Biochemistry*; **15**: No. 17, 3834-3842(24 Aug 1976).

The active transport and internal binding of the Ca^{2+} analogue Mn^{2+} by rat liver mitochondria were monitored with electron paramagnetic resonance. The binding of transported Mn^{2+} depended strongly on internal pH over the range 7.7 - 8.9. Gradients of free Mn^{2+} were compared with K^+ gradients measured on valinomycin-treated samples. In the steady state, the electrochemical Mn^{2+} activity was larger outside than inside the mitochondria. The observed gradients of free Mn^{2+} and of H^+ could not be explained by a single "passive" uniport or antiport mechanism of divalent cation transport. This conclusion was further substantiated by observed changes in steady-state Ca^{2+} and Mn^{2+} distributions induced by La^{3+} and ruthenium red. Ruthenium red reduced total Ca^{2+} or Mn^{2+} uptake, and both inhibitors caused release of divalent cation from preloaded mitochondria. A model is proposed in which divalent cations are transported by at least two mechanisms: a passive uniport and an active pump, cation antiport or anion symport. The former is more sensitive to La^{3+} and ruthenium red. Under energized steady-state conditions, the net flux of Ca^{2+} or Mn^{2+} is inward over and outward over. The need for more than one transport system in regulating cytoplasmic Ca^{2+} is discussed.

CYTOLOGY

REFER ALSO TO CITATION(S) 3928, 3930, 3936, 4011

3897 (LA—6451-PR) Effects of cadmium on karyotype stability in Chinese hamster ovary cells. Progress report, January 1—June 30, 1976. Deaven, L.L.; Campbell, E.W. (Los Alamos Scientific Lab., N.Mex. (USA)). Aug 1976. Contract W-7405-ENG-36. 4p. Dep. NTIS $3.50.

Cadmium chloride solutions were added to cultures of hamster ovary cells in various concentrations and cells were examined for chromosomal aberrations at intervals. At a concentration of 2×10^{-6} M, cells showed no damage up to 24 h; at 48 h about 40 percent of cells showed chromatid damage; at 72 h 80 percent of metaphase cells had shattered chromosomes; after 1 week an increased number of tetraploid cells appeared. All concentrations had an inhibitory effect on mitosis. (HLW)

3898 (UCRL—78284) Flow karyotyping: current status and potential development. Van Dilla, M.A.; Carrano, A.V.; Gray, J.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 2 Jun 1976. Contract W-7405-Eng-48. 2p. (CONF-751158—3). Dep. NTIS $3.50.

From Workshop on automated cytogenetics; Pacific Grove, California, USA (30 Nov 1975).

Suspensions of metaphase chromosomes from Chinese hamster, Indian muntjac and human tissue culture cells were stained for DNA with the fluorochrome, ethidium bromide, and analyzed by flow cytometry to produce a DNA distribution or flow karyotype unique for each species. The flow karyotype is a representation and chromosomal DNA content and relative chromosome frequency. The time for the measurement and data reduction is about ten minutes per 10^6 chromosomes. Aberrant chromosomes have been detected by flow karyotype changes. Improvements of flow karyotyping and the feasibility of this technique for monitoring human populations for cytogenetic alterations are discussed. (auth)

3899 (UCRL—78397) **Image analysis, flow fluorometry, and flow sorting of mammalian chromosomes.** Mendelsohn, M.L.; Carrano, A.V.; Gray, J.W.; Mayall, B.H.; Van Dilla, M.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 16 Jul 1976. Contract W-7405-eng-48. 29p. (CONF-751219—2). Dep. NTIS $4.00.

From Conference on molecular biology of the mammalian genetic apparatus, its relationship to cancer aging and medical genetics; Pasadena, California, USA (8 Dec 1975).

The measurement and manipulation of chromosomes using two very different techniques are discussed. The first is absorption cytophotometry coupled to image analysis, a method which measures relative DNA content and centromere index of preidentified chromosomes within the well flattened metaphase cell on a microscope slide. The second is flow fluorometry and sorting, a technique which requires chromosomes in suspension, measures relative DNA content and sorts or separates chromosomes within specified ranges of DNA content. The image-analytic approach uses traditional preparations and can be directly coupled to traditional analysis; as presently practiced it is slow but immediately applicable to human cytogenetics. The flow fluorometric approach uses nonconventional preparations and a nonconventional chromosomal rather than cellular framework for the analysis; it is extremely rapid, unique in its ability to purify chromosomes, and potentially but not immediately applicable to clinical cytogenetics.

3900 (UCRL—78412) **Cytophotometric analysis of human chromosomes.** Mayall, B.H.; Carrano, A.V.; Moore, D.H. II.; Ashworth, L.K.; Bennett, D.E.; Bogart, E.; Littlepage, J.L.; Minkler, J.L.; Piluso, D.L.; Mendelsohn, M.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 2 Aug 1976. Contract W-7405-eng-48. 12p. (CONF-761201—1). Dep. NTIS $3.50.

From ERDA workshop on automated cyogenetics; Pacific Grove, California, United States of America (USA) (2 Dec 1976).

Scanning cytophotometry was used to measure the amount of DNA in individual human metaphase chromosomes. The technique is exquisitely sensitive and allows the detection of chromosomal differences, both among and within individuals, that are not resolved by any other current method.

3901 **Cell cycle specificity of the morphological conversion of Chinese hamster ovary cells by N^6,-$O^{2'}$-dibutyryl cyclic adenosine 3',5'-phosphate.** O'Neill, J.P.; Schroeder, C.H.; Riddle, J.C.; Hsie, A.W. (Oak Ridge National Lab., TN). *Exp. Cell Res.;* **97**: 213-217(1976).

Incubation of Chinese hamster ovary (CHO) cells with N^6,$O^{2'}$dibutryl cyclic adenosine 3 ,5 -phosphate (db-cAMP) causes the epithelial-like cells to assume a fibroblast-like morphology. We have analysed this morphological conversion in cells synthronized by the mitotic shake-off method. Here, we report that only cells in the G1 phase of the cell cycle initiate elongation when incubated with db-cAMP. (auth)

3902 **Raman spectroscopic investigations of sarcoplasmic reticulum membranes.** Milanovich, F.P. (Lawrence Livermore Lab., CA); Yeh, Y.; Baskin, R.J.; Harney, R.C. *Biochim. Biophys. Acta;* **419**: 243-250(1976).

Raman spectra are presented for sarcoplasmic reticulum membranes. Interpretation of the 1000 to 1130 cm^{-1} region of the spectrum indicates that the sarcoplasmic reticulum membrane may be more fluid than erythrocyte membranes that have been examined by the same technique. The fluidity of the membrane also manifests itself in the amide I portion of the membrane spectrum with a strong 1658 cm^{-1} band characteristic of C = C stretching in hydrocarbon side chains exhibiting cis conformation. This band is unaltered in intensity and position in H_2O and in ^2H_2O thus obscuring amide I protein conformation. Of particular interest is the appearance of strong, resonantly enhanced bands at 1160 and 1527 cm^{-1} attributable to membrane-associated carotenoids. (auth)

3903 **Role of cytogenetics in hematology.** Rowley, J.D. (Univ. of Chicago). *Blood;* **48**: No. 1, 1-7(Jul 1976).

Evidence is accumulating that various nonrandom chromosomal patterns are found in myeloproliferative disorders. Although none of these patterns shows the same degree of specificity as the Ph^1 chromosome in CML, their detection lends support to the hypothesis that chromosomal changes play an important role in these diseases. Chromosomal analysis of bone marrow cells by use of banding techniques has become an integral part of the careful investigation of virtually any group of patients with a particular hematologic disorder and may prove useful in guiding the clinician in the prognosis and therapy of these disorders. The correlation of the clinical findings with the cytogenetic, morphological, and biochemical analyses will provide a much more complete understanding of these diseases than can be achieved with any one of these techniques used alone.

3904 **Acute nonlymphocytic leukemia in adults: correlations with Q-banded chromosomes.** Golomb, H.M.; Vardiman, J.; Rowley, J.D. (Univ. of Chicago). *Blood;* **48**: No. 1, 9-21(Jul 1976).

Chromosome banding patterns were obtained for 50 of 55 consecutive adult patients with acute nonlymphocytic leukemia during a 5-yr period. Twenty-two of the 50 cases were diagnosed as acute myelocytic leukemia (AML), 24 as acute myelomonocytic leukemia (AMMol), 2 as acute promyelocytic leukemia (APL), and 2 as erythroleukemia. Twenty-five patients had initial chromosome abnormalities, and five more patients developed abnormalities during the course of the disease. The median survival of patients with normal chromosomes initially (group 1) was 10 mo, whereas that of patients with abnormal chromosomes initially (group II) was 2 mo. Similar times were obtained for treated patients with AML and AMMol. However, when the AML patients were separated into those with and those without a chromosome abnormality, the median survival times were markedly different (2 mo versus 18 mo, respectively). Patients with AMMol demonstrated no difference in median survival times when subgrouped according to the presence or absence of chromosome abnormalities. The treated group II patients whose marrow samples had only abnormal metaphases had a poorer response (10 percent complete remission) and median survival (2 mo) than the group II patients who had at least one normal metaphase (42 percent complete remission with a median survival of 9 mo). The two cases of APL demonstrated a deletion of the long arm of No. 17 which occurred in the same region of the chromosome in each case. Both patients had similar clinical histories, with disseminated intravascular coagulation, and neither responded to therapy.

3905 **Further characterization of the circulating cell in chronic lymphocytic leukemia.** Schutz, E.F.; Davis, S.; Rubin, A.D. (Coll. of Medicine and Dentistry of New Jersey, Newark). *Blood;* **48**: No. 2, 223-234(Aug 1976).

Peripheral lymphocytes from normal individuals and from patients with chronic lymphocytic leukemia (CLL) were cultured in vitro for 1-7 days. The growth response to phytohemagglutinin (PHA) was quantitated by the incorporation of tritiated uridine into RNA nucleotide during a 2-hr pulse with the radioisotope. While the maximum response in PHA-stimulated normal cultures appeared at 2-3 days, CLL cultures required 5-7 days to develop their maximal response, which was 50 percent-60 percent of the normal magnitude. Dilution of the number of normally reactive lymphocytes by culturing them with totally unreactive, mitomycin-treated cells produced a normal 72-hr maximal response, no matter what proportion of unreactive cells was included in the PHA-stimulated cultures. In addition, the response of peripheral lymphocytes from patients with myeloblastic leukemia, where large numbers of unreactive myeloblasts diluted the normal small lymphocytes, a depressed reaction occurred at the anticipated 2-3 days. Nylon fiber-adherent lymphocytes consisting of 85 percent immunoglobulin (Ig)-bearing cells responded minimally to PHA, but showed no evidence of a delay. When isolated from CLL patients, both fiber-adherent cells (ig-bearing) as well as non-fiber-adherent (sheep erythrocyte-rosetting) cells responded to PHA in a delayed fashion. Similarly, a case of CLL, in which 93.5 percent of the circulating lymphocytes bore sheep red blood cell receptors, showed its peak response to PHA at 7 days. Therefore, using surface marker criteria considered characteristic of normal T cells and B cells, the delayed response to PHA on the part of CLL lymphocytes was independent of thymic or nonthymic origin.

3906 **Selective isolation of reversible cold sensitive variants from Chinese hamster ovary cell cultures.** Ohlsson-Wilhelm, B.M.; Freed, J.J.; Perry, R.P. (Inst. for Cancer Research, Philadelphia). *J. Cell. Physiol.;* **89**: No. 1, 77-88(Sep 1976).

Variants of the Chinese hamster ovary cell line CHO-K1 (ATCC CCL 61) which grow almost normally at 38.5°C but very poorly or not at all at 30°C were obtained after treatment with mutagens and application of an indirect selection procedure. Two kinds of variants were recovered. In the first of these, the cold sensitive phenotype is expressed completely only at low cell densities. At higher cell density, growth continues at the nonpermissive temperature, but at a reduced rate. In the second class, the cold sensi-

tive phenotype is independent of cell density. Two members of the latter class were studied in detail. In both lines, after shift to the nonpermissive temperature, the rate of ^{3}H-thymidine incorporation declines markedly; the rates of ^{3}H-uridine and ^{3}H-phenylalanine uptake are less drastically reduced. Autoradiographs indicate that the decline in thymidine uptake at the nonpermissive temperature is due to an elongation of part of the cell cycle, so that a smaller proportion of the cells lie in the synthetic (S) phase of the cell cycle with a consequent reduction in the fraction of labeled cells. The uridine labeling patterns of the mutants appear to rule out a ribosomal lesion. Low temperature growth inhibition of both cell strains was reversible. In one of the cell lines, an apparent stretching of the cells at the low temperature produces substantial alterations in cell shape.

GENETICS

REFER ALSO TO CITATION(S) 3856, 3898, 3899, 3903

3907 (COO—2472-2) **Study of mathematical models of mutation and selection in multi-locus systems. Annual progress report, September 1, 1975—August 31, 1976.** Lewontin, R.C. (Harvard Univ., Cambridge, Mass. (USA)). 1976. Contract E(11-1)-2472. 13p. Dep. NTIS $3.50.

Findings of this year's work include in a cyclically fluctuating environment, linked systems go to fixation more slowly than unlinked ones; in cyclically fluctuating environments to a first order of approximation, geometric mean fitness is maximized; in a continuously deteriorating environment, selection for equilibrium genetic variance will always occur; in a cyclically fluctuating environment, selection for genetic variance will occur only if the amplitude of the fluctuation is greater than a certain value determined by the period of the oscillation; partial selfing puts less of a restriction on fitnesses necessary for balanced polymorphism when linked loci are segregating than for single loci; frequency dependent fitness may result in "chaotic"dynamic behavior with no gene frequency as a stable equilibrium.

3908 (COO—2497-07) **Genetic and developmental study of a complex locus in the house mouse. Progress report, August 1, 1974—July 31, 1976.** Bennett, D. (Cornell Univ., New York (USA). Medical Coll.). Apr 1976. Contract E(11-1)-2497. 8p. Dep. NTIS $3.50.

We have maintained and studied seven dominant T-like mutations, eleven recessive lethal t-alleles in six different complementation groups, two semilethal t-mutations, and fifteen viable t-variants in the house mouse. Seven of the latter are newly arisen and have been characterized during this year. Six other, non T/t locus, markers are also maintained. Interest has centered on the following three points: further analysis of the four different types of dominant T-mutations that we have available shows that two of these, and possibly a third, seem to have chromosome abnormalities associated with them; the etiology of the maternal effect seen in T/sup Hp/ has also been studied, and no mechanism has yet been found, although trisomy 17 has been excluded; eleven new alleles derived by recombination in lethal t-mutations have been fully or substantially analyzed; and attempts at fine structure mapping of the T-tf region in the presence of two other mutations (t^{38} and Low) have produced anomalous results that suggest that the presence of t^{38} and Low in the trans position may interfere with crossing over in the t^{38}-Low interval.

3909 **Evidence that Linkage Group IV as well as Linkage Group X of the mouse are in chromosome 10.** Cacheiro, N.L.A.; Russell, L.B. (Oak Ridge National Lab., TN). *Genet. Res.*; **25**: 193-195(1975).

Four translocations in which one breakpoint was known to be at or closely linked to the LGIV marker Steel, Sl, were studied in an attempt to identify cytologically the as yet unassigned Linkage Group IV of the mouse. The cytological results indicate that chromosome 10, which had previously been matched with LGX, is involved in each of the four translocations, the break being in 10 D. Recombination between Sl and the LGX marker grizzled, gr, was determined to be 6 to 14 percent. The combined cytological and genetic results indicate the LGIV and LGX are both in chromosome 10, and that the order may be centromere-gr-Sl. (auth)

3910 **Isoaccepting mitochondrial glutamyl-tRNA species transcribed from different regions of the Mitochondrial genome of Saccharomyces cerevisiae.** Martin, N. (Univ. of Chicago); Rabinowitz, M.; Fukuhara, H. *J. Mol. Biol.*; **101**: 285-296(1976).

Mitochondrial glutamyl-tRNA isolated from mitochondria of Saccharomyces cerevisiae was separated into two distinct species by reversed-phase chromatography. The migration of the two mitochondrial glutamyl-tRNAs (tRNA/sub I//sup Glu/ and tRNA/sub II//sup Glu/) differed from that of two glutamyl-tRNA species found in the cytoplasm of a mitochondrial DNA-less petite strain. Both mitochondrial tRNAs hybridized with mitochondrial DNA. Three lines of evidence demonstrate that mitochondrial tRNA/sub I//sup Glu/ and tRNA/sub II//sup Glu/ are transcribed from different mitochondrial cistrons. First the level of hybridization of a mixture of the two tRNAs to mitochondrial DNA was equal to the sum of the saturation hybridization levels of each glutamyl-tRNA alone. Second, the two mitochondrial glutamyl-tRNAs did not compete with each other in hybridization competition experiments. Finally the tRNAs showed individual hybridization patterns with different petite mitochondrial DNAs. Hybridization of the tRNAs to mitochondrial DNA of genetically defined petite strains localized each tRNA with respect to antibiotic resistance markers. The two glutamyl-tRNA cistrons were spatially separated on the genetic map.

METABOLISM

REFER ALSO TO CITATION(S) 3866

3911 (COO—2403-5) **Early steps in protein synthesis and their regulation: a background study related to the biological effects of radiation. Progress report, July 1, 1975—June 30, 1976.** Zamecnik, P.C. (Massachusetts General Hospital, Boston (USA). John Collins Warren Labs.). Mar 1976. Contract E(11-1)-2403. 32p. Dep. NTIS $4.00.

This is a continuing study of protein synthesis, involving a search for the role of Ap_4A and other unusual nucleotides in growth regulation; studies of the mechanism of action of aminoacyl-tRNA ligases and the effect thereof on protein synthesis; a search for new regulators of the translation step, in cell-free systems; and an effort to improve the sensitivity and quantitation of chemical sequencing at the 3'-end of messenger RNA.

3912 (COO—3139-23) **Proteins in growth regulation during early development of the chick embryo. Progress report, May 1975—May 1976.** Klein, N.W. (Connecticut Univ., Storrs (USA). Dept. of Animal Genetics). 1 Apr 1976. Contract E(11-1)-3139. 16p. Dep. NTIS $3.50.

Previous studies have shown that the growth of embryo regions and the synthesis of specific proteins in embryo regions were altered when early chick embryos were cultured on various nutrient proteins. Because nutrient proteins were degraded to constituent amino acids within the yolk-sac and did not reach the embryo proper as intact macromolecules, we have been evaluating the role of the yolk-sac in the regulation of early embryonic growth and development. The synthesis of serum proteins by the yolk-sac was observed to start as early as the primitive streak stage of development. The relative synthesis of the individual serum proteins was found to change with development, with changes in protein nutrition, and with drug induced developmental abnormalities.

3913 (COO—3231-4) **Effect of light on respiration and development of photosynthetic cells. Progress report, September 1, 1975—June 1, 1976.** Gibbs, M. (Brandeis Univ., Waltham, Mass. (USA)). 1 Jun 1976. Contract E(11-1)-3231. 33p. Dep. NTIS $4.00.

Adaptation and deadaptation of unicellular algal cells to a hydrogen metabolism may involve not only hydrogenase but also the site of entry of electrons from NADH. NADPH can also serve as an electron donor in a chloroplast preparation fortified with hydrogenase but the rate of photoevolution falls off rapidly perhaps due to competition with NADP for electrons. The evolution of H_2 with reduced pyridine nucleotide as electron donor is coupled to ATP formation. Evidence is presented that soluble ferredoxin may not be the immediate donor of H_2. Hydrogenases from Chlamydomonas and Scenedesmus have been highly purified and will be used to test the stoichiometry of NADH disappearance, ATP and H_2 formation and also whether H_2-photoevolution in contrast to dark evolution is ferredoxin dependent. Studies with intact Chlamydomonas provide evidence that a reduced carbon compound and not water is the source of H_2. The presence of acetate eliminates the CO_2 production. The ratio of CO_2:H_2 is 1:2 and evolution is blocked by inhibitors of glycolysis. Acetate has a strong effect on H_2O. Cells starved over a long period still retain photoreduction but will not evolve H_2 until glucose is added.

3914 (ORNL/CSD—3) **Experimentally based systems-theoretic approach to the study of metabolism. I. Substrate perturbation.** Kretchmar, A.L.; Price, E.J.; Heidel, J.W.; Serbin, S.M. (Oak Ridge National Lab., Tenn. (USA)). Jul 1976. Contract W-7405-eng-26. 16p. Dep. NTIS $3.50.

This paper begins a series of reports on a new approach to the study of intermediary metabolism. We describe the experimental procedures for analyzing metabolic transformation of ^{14}C-labeled amino acids in mice. Qualitative information is obtained by applying the concept of substrate perturbation. The input function is unlabeled and/or ^{14}C-labeled amino acids, and the output function is specific activity of respiratory CO_2. The theoretical justification for modeling the metabolic system with linear differential equations is given.

3915 (RLO—2225-T19-34) **Progress report, July 1, 1974—July 1, 1975.** Cleland, R. (Washington Univ., Seattle (USA). Dept. of Botany). 1975. Contract AT(45-1)-2225-T19. 12p. Dep. NTIS $3.50.

Progress is reported on studies on the role of auxin in plant cell elongation. Biochemical reactions in Avena (oats) coleoptiles are discussed. (CH)

3916 Nitrogen requirement and its relation to dietary water and potassium content in the lizard Sauromalus obesus. Nagy, K.A. (Univ. of California, Los Angeles). *J. Comp. Physiol.*; **104**: 49-58(1975).

Nitrogen metabolism was measured in chuckwallas (Sauromalus obesus) fed synthetic diets constructed to simulate various field diets. Responses to different dietary K^+ and water contents were investigated as well, because the production of K^+-containing semisolid "urate" pellets by these lizards may involve physical or chemical interdependence of nitrogen, K^+ and water excretion. Minimum digestible nitrogen requirement was 175 mg N/(kg x day) or 109 mg N/(kg/sup 0.75/ x day) for a diet containing normal levels of water and K^+. In response to a more succulent diet, as occurs in the field in early spring, chuckwallas stored nitrogen when nitrogen assimilation exceeded the minimum requirement. When dietary K^+ concentration was reduced, nitrogen excretion was lower, and conversely, elevated dietary K^+ levels elicited increased nitrogen excretion rates. Molar ratios of precipitated (water insoluble) K^+ to "urate" (estimated from total urine nitrogen) ranged from 0.01 for low K^+ diets to 3.17 for the normal K^+, low nitrogen diet. Chuckwallas may accumulate nitrogen in spring, when food plants contain much water and nitrogen. Later in the year, when field diets contain little water or nitrogen but high K^+ concentrations, chuckwallas may use their stored nitrogen to offset increased excretory nitrogen losses. (auth)

3917 Turnover of ribosomal RNA in mouse fibroblasts (3T3) in culture. Kolodny, G.M. (Massachusetts General Hospital, Boston). *Exp. Cell Res.*; **91**: 101-106(1975).

Growing and confluent cultures of mouse fibroblasts were labeled with ^3H-uridine and chased with an excess of nonradioactive uridine to investigate the turnover of ribosomal RNA. Growing cultures did not turn over their 18S and 28S ribosomal RNA; however, confluent cultures did show ribosomal RNA (rRNA) turnover. If the cells were labeled while growing and chased when confluent, 18S RNA displayed a two-component decay curve, while 28S RNA showed only single-component decay, similar in lifetime to the first component of the 18S RNA decay curve. If the cells were labeled while confluent, both the 18S and 28S RNA showed single-component decay curves with a lifetime possibly only slightly longer than the lifetime of the first component of the 18S RNA and the single component of the 28S RNA of the cultures labeled while growing.

3918 Hydrogen ion entry as a controlling factor in the acid-growth response of green pea stem sections. Cleland, R.E. (Univ. of Washington, Seattle); Rayle, D.L. *Plant Physiol.*; **55**: No. 3, 547-549(Mar 1975).

The ability of green pea (Pisum sativum var. Alaska) stem sections to elongate in response to H^+ has been investigated. Contrary to the conclusions of Barkley and Leopold, (Plant Physiol. 1973. 52: 76-78) these sections elongate in response to H^+ whenever H^+ entry through the cuticle is facilitated by slits, holes, or removal. Both live and frozen-thawed sections can undergo acid-induced elongation. Green pea stems behave as predicted by the acid-growth theory. (auth)

3919 Chronic inhalation of nickel oxide and cigarette smoke by hamsters. Wehner, A.P.; Busch, R.H.; Olson, R.J.; Craig, D.K. (Battelle Pacific Northwest Labs., Richland, WA). *Am. Ind. Hyg. Assoc. J.*; **36**: No. 11, 801-808(Nov 1975).

Chronic inhalation of NiO and cigarette smoke (CS) by hamsters eventually caused pneumoconiosis whose development was unaffected by CS. No carcinogenic or cocarcinogenic effect of NiO and CS was observed. CS exposure increased laryngeal lesions, reduced body weight, and increased lifespan. (auth)

3920 Erythropoietin production by human renal carcinoma cells in culture. Sherwood, J.B.; Goldwasser, E. (Univ. of Chicago). *Endocrinology*; **99**: No. 2, 504-510(Aug 1976).

Cells from human renal tumors were grown in monolayer cultures, and the media obtained at each medium change were assayed for erythropoietin activity. The medium from carcinoma I (a granular cell tumor) contained a high level of activity initially. The concentration of erythropoietin activity decreased with time in culture, but was significantly higher than that in controls after four months in vitro. There was, in addition, evidence of an inhibitory material present in the culture media. The activity formed by the tumor cells could be neutralized by an antibody to human urinary erythropoietin. The difference between activity measured in marrow cell cultures and that found by in vivo assay, and the chromatographic properties of the active preparation, suggest that the tumor-derived activity may be largely asialoerythropoietin. Two other renal carcinomas, of a different cellular type, produced significant erythropoietic activity.

3921 Reversible independent alterations in glucose transport and metabolism in cultured human cells deprived of glucose. Salter, D.W.; Cook, J.S. (Univ. of Tennessee, Oak Ridge). *J. Cell. Physiol.*; **89**: No. 1, 143-155(Sep 1976).

We have measured uptake of ^3H-hexoses into diploid human cells by exposing them to brief pulses of isotopic sugar during the log-growth, subconfluent-growth, and confluent-growth (contact inhibited) phases of the strain HSWP derived from human skin. ^3H-deoxyglucose appears to be taken up three times faster than ^3H-glucose. After exposure to ^3H-glucose for longer than one minute, the cells excrete approximately 70 percent of the isotope into the medium as lactate. If lactate production (and hence excretion) is abolished by treating the cells with iodoacetic acid or dinitrofluorobenzene, neither of which inhibits transport, the uptake of ^3H-glucose is found to be in fact somewhat larger than that of ^3H-deoxyglucose. If cells are deprived of glucose for 24 hours, apparent uptake of ^3H-glucose is enhanced 10-fold or more. This latter increase is accounted for by 2- to 3-fold enhancement of true transport plus retention of greater than 90 percent of the radioactivity, since little lactate is formed or excreted in glucose-deprived cells. Deoxyglucose, galactose, or pyruvate when present during glucose deprivation each have quantitatively different effects on the cells' capacity to produce lactate from a short pulse of glucose, but none of them prevents the enhancement of hexose transport. After restoration of 5 mM glucose to starved cells, their metabolism returns to normal (in the sense that approximately 70 percent of the glucose taken up in a pulse is again excreted as lactate), with a half-time of 0.5 hour; but the transport of hexoses returns to control levels much more slowly, with a half-time of approximately 6 hours. The two processes appear to be independently regulated.

MEDICINE

REFER ALSO TO CITATION(S) 3775

TRACER TECHNIQUES

REFER ALSO TO CITATION(S) 3745, 3746, 3751, 3752, 3753, 3758, 3914

3922 (COO—3253-5) **Integro-differential equation analysis and radioisotope imaging systems. Research proposal.** Hart, H. (City Coll., New York (USA); City Univ. of New York, N.Y. (USA). Research Foundation). 9 Mar 1976. Contract E(11-1)-3253. 145p. Dep. NTIS $6.00.

Design modifications of a five-probe focusing collimator coincidence radioisotope scanning system are described. Clinical applications of the system were tested in phantoms using radioisotopes with short biological half-lives, including ^{75}Se, ^{192}Ir, ^{43}K, ^{130}I, and ^{82}Br. Data processing methods are also described. (CH)

3923 Radionuclides in nephrology. Symposium held in Berlin, Germany, April 1—3, 1974. zum Winkel, K.; Blaufox, M.D.; Funck-Brentano, J.L. (eds.). Stuttgart; Georg Thieme Verlag (1975). 343p. (CONF-740475—). DM 68,-.

From 3. international symposium on the radionuclides in nephrology; Berlin, F.R. Germany (1 Apr 1974).

Many types of inquiry in clinical and basic sciences are important for the maintenance and development of sound standards for the use of radionuclides in nephrology. Therefore, the program of the meeting covered a wide range of topics: renal blood flow, functional and morphological studies, radioimmunoassay, renal transplantation, renal handling of radioactive compounds, metabolic studies in renal disease and clearance determinations. During the last decade nuclear medicine has been the fortunate recipient of the benefits of a rapidly improving technology and impressive

progress in biochemical methodology. The overwhelming variety of methods presently used in kidney research was demonstrated at the symposium. The techniques included electron microscopy, kidney microdissection, radioimmunoassay, autoradiography, ultrasonography, clearance determinations, kinetic analysis of radiopharmaceuticals and computational data processing.

3924 Determination of specific radioactivity of amino acids in proteins directly on polyacrylamide gels: an application to L-leucine. Martin, A.F.; Prior, G.; Zak, R. (Univ. of Chicago). *Anal. Biochem.*; **72**: No. 1/2, 577-585(7 May 1976).

A method has been developed for determination of the specific radioactivity of L-leucine in different proteins or protein subunits which have been separated by polyacrylamide gel electrophoresis. After electrophoresis, the proteins are visualized by staining with Coomassie Brilliant Blue R, and the desired bands are excised and hydrolyzed with hydrochloric acid. In one aliquot of the hydrolysate, the radioactivity is determined, and in another, the amino acid concentration. For this purpose, we have employed an isotope dilution procedure, using the aminoacyl synthetase reaction. With this technique, 100—1500 picomol of a single amino acid can be detected.

3925 Kinetics and imaging characteristics of /sup 99m/Tc labeled complexes used for bone imaging. Weber, D.A.; Keyes, J.W. Jr.; Wilson, G.A.; Landman, S. (Univ. of Rochester, NY). *Radiology;* **120**: No. 3, 615-621(Sep 1976).

From 60. scientific assembly and annual meeting of the Radiological Society of North America; Chicago, IL, USA (1 Dec 1974).

Activity levels of /sup 99m/Tc-labeled compounds, ^{18}F, and ^{85}Sr were obtained at 1, 3, and 5 hr postinjection in normal and healing fractured bone and in soft-tissue rat specimens. Serial diagnostic bone images and blood and urine kinetics were obtained in patients with each of the Tc-labeled compounds. Computer-processed images were used to evaluate in vivo kinetics. /sup 99m/Tc pyrophosphate provides the best overall characteristics for bone imaging. Improved quality and bioassay procedures are required, however, before any one agent can be designated the radiopharmaceutical of choice for diagnostic bone imaging.

3926 Imaging of tumors involving bone with ^{13}N-glutamic acid. McDonald, J.M.; Gelbard, A.S.; Clarke, L.P.; Christie, T.R.; Laughlin, J.S. (Memorial Sloan-Kettering Cancer Center, New York). *Radiology;* **120**: No. 3, 623-626(Sep 1976).

Nitrogen-13 labeled L-glutamic acid was evaluated as an imaging agent for tumors involving bone. The enzymatically prepared labeled compound was administered intravenously to dogs with spontaneous tumors, and tumor uptake was determined with a gamma camera and rectilinear scanner. These tumors were well visualized with ^{13}N-glutamic acid, and the results compared favorably with uptake studies performed on the same animals with /sup 99m/Tc-diphosphonate.

MICROBIOLOGY

REFER ALSO TO CITATION(S) 3888, 3889

3927 (UR—3055-16) **Factors involved in the regulation of early enzyme synthesis and lysis of Escherichia coli B infected with bacteriophage T4D.** Thompson, S. (Rochester Univ., N.Y. (USA). School of Medicine and Dentistry). 1976. Contract E(11-1)-3055. 130p. Dep. NTIS $6.00.

Thesis.

The capability of $T4^+$-infected Escherichia coli cells to display handling-induced lysis may implicate the activity of a known, untested gene, or a heretofore undiscovered gene. This gene product may be involved in the normal lytic process; it may be a new phage-induced phospholipase or a late function that activates a latent E. coli phospholipase. Another possibility is that the late function is involved in membrane biosynthesis or modification. Alternatively, the required late protein(s) may have some other role that only secondarily affects the cell's permeability barrier. Whatever the case may be, this work is of practical interest since chilling and centrifugation of infected cells are very common procedures and researchers should be aware of any handling-induced damage.

3928 Use of micromanipulators in yeast studies. Sherman, F. (Univ. of Rochester, NY). pp 189-199 of In Methods in cell biology. XI. Yeast Cells. Prescott, D.M. (ed.). New York; Academic Press (1975).

Micromanipulators are used in yeast genetic studies not only for the separation of ascospores from individual asci, but also for the separation of zygotes from mass-mating mixtures and in special cases for positioning of vegetative cells and spores for mating purposes and for single-cell analyses. The dissection of asci by free hand, not requiring micromanipulators, is dealt with separately in this volume. (auth)

PATHOLOGY

REFER ALSO TO CITATION(S) 3846, 3919, 3932

3929 (COO—910-40) **Relationships between "C" type particle production, nuclear pocket frequency and immunofluorescense serology titer in calves inoculated with bovine "C" type particles.** Pomeroy, K.A.; Olson, J.M. (Minnesota Univ., St. Paul (USA). Dept. of Veterinary Clinical Science). 1975. Contract E(11-1)-910. 15p. (CONF-7509138—1). Dep. NTIS $3.50.

From Midwest interprofessional seminar on diseases common to animals and man; Iowa City, Iowa, United States of America (USA) (23 Sep 1975).

Progress is reported on studies on the etiology and pathogenesis of bovine leukemia following inoculation of newborn calves and fetuses up to 60 days prior to birth with lymphocytes from infected source animals. (CH)

3930 Induction of mitosis in ocular tissue by chemotoxic agents. Weinsieder, A. (Wayne State Univ., Detroit); Briggs, R.; Reddan, J.; Rothstein, H.; Wilson, D.; Harding, C.V. *Exp. Eye Res.*; **20**: 33-44(1975).

Ocular inflammation has been induced in a number of species by a variety of chemical agents, including methylene blue. Initial cell destruction and subsequent repopulation by mitogenesis in lens epithelium and corneal endothelium were observed using techniques for living and fixed tissue. During the course of the chemical inflammation response, the lens displayed a prominent, anterior pole subcapsular opacity underlying the area of maximal epithelial destruction. Near-normal transparency returned with recovery of the lens tissue cytoarchitecture. Elevated protein concentrations in aqueous humor were found throughout the course of the experiments. Similar alterations in aqueous humor were observed in the course of immunogenic uveitis although lenticular or corneal endothelial destruction and subsequent proliferation were not detected.

3931 New aspects on dust and pneumoconiosis research. Klosterkoetter, W.; Robock, K. (Univ. of Essen). *Am. Ind. Hyg. Assoc. J.*; **36**: No. 9, 659-668(Sep 1975).

The lecture deals with pneumoconiosis, in particular with fibrotic tissue reactions caused by SiO_2 and asbestos dusts in the lungs. The term "fine dusts" is defined in connection with the setting up of maximum allowable concentration (MAC)-values. The aerodynamical diameter of particle shaped and fibriform dust is set forth. Results of the fundamental research with SiO_2, coal mine and asbestos dusts in animal and cell experiments are explained. (auth)

TRACER TECHNIQUES

3932 (BNL—21463) **Genetic influence on hypertension induced by cadmium in Dahl hypertension-resistant and hypertension-sensitive rats.** Ohanian, E.V.; Dahl, L.K.; Iwai, J. (Brookhaven National Lab., Upton, N.Y. (USA)). 1976. Contract E(30-1)-16. 10p. (CONF-760632—3). Dep. NTIS $3.50.

From 10. annual conference on trace substances in environmental health; Columbia, Missouri, United States of America (USA) (8 Jun 1976).

Dahl hypertension-resistant (R) and hypertension-sensitive (S) rats, with opposite genetically controlled propensities for hypertension, were used to determine if cadmium-induced hypertension was also dependent upon genetic predisposition. When intraperitoneal injections of cadmium (1 and 2 mg/kg) were given to male and female R and S rats maintained under ordinary laboratory conditions, female S rats manifested a significant increase in blood pressure which persisted for 16 weeks, whereas the R rats and the male S rats showed no significant changes in blood pressure. Cadmium had no effect on body weight. The concentrations of cadmium in hepatic and renal tissues of cadmium-injected male and female S rats were significantly higher than that of R rats. The kidneys of female S rats given cadmium showed renal vascular changes in accord with renal hypertension of moderate degree. We concluded that differences in genetic substrate influence the pathogenesis of experimental cadmium-induced hypertension.

PHYSIOLOGICAL SYSTEMS

REFER ALSO TO CITATION(S) 3871, 3942, 4004, 4012

3933 Yearly variation in larval survival of Ambystoma maculatum. Shoop, C.R. (Univ. of Rhode Island, Kingston). *Ecology;* **55**: 440-444(1974).

Survivorship of larval Ambystoma maculatum from a single pond varied each year although the variability was not dependent on the number of eggs deposited each year. The survival depends greatly on developmental rates of the larvae, pond duration, and suitable climatic conditions at the time of dispersal. The variations in length of the larval period appear adaptive and cannot be explained by variation in dates of egg deposition. Developmental rates may be altered slightly by environmental factors. (auth)

3934 Age and lipids of the central nervous system: lipid metabolism in the developing brain. Dhopeshwarkar, G.A.; Mead, J.F. (Univ. of California, Los Angeles). pp 119-132 of In Aging. Vol. 1. Brody, H. (ed.). New York; Raven Press (1975).

The lipids of the CNS exhibit marked changes during the early period of life. For example, in the rat, the period of maximum changes in brain lipids is between the first and third week after birth. After about $1^1/_2$ months these variations level off. During the rest of the aging period it appears that as neutrons and accompanying myelin are gradually lost, their total lipid component decreases. However, the fatty acid pattern is definitely affected during this aging period. This reflects in a decrease in unsaturation with age resulting in an increased proportion of saturated fatty acids of progressively increased chain length. There is also an accumulation of α-hydroxy and odd-chain fatty acids. The physiological implications of these changes are still not known, but it is generally believed that they add to the stability of the myelin, and this could be a reason for a very gradual age-dependent decrease in myelin lipids. (auth)

3935 Growth of the desert tortoise (Gopherus agassizi) in Nevada. Medica, P.A.; Bury, R.B.; Turner, F.B. *Copeia;* No. 4, 639-643(31 Dec 1975).

Between 1963 and 1973, growth of the desert tortoise (Gopherus agassizi) in southern Nevada averaged about 9 mm per year. Yearly increments were estimated for 5 years (1969 to 1973) and ranged from a low of 1.8 mm in 1972 to a high of 12.3 mm in 1969. Growth was greatest following winters of high precipitation, which resulted in increased production of winter annuals in the spring. Growth of tortoises generally occurred between April and July. The weight, W(g), of tortoises may be estimated as W =0.000258X/sup 2.98/ with X the plastron length in mm. (auth)

3936 Freezing and low-temperature storage of living cells. Mazur, P. (Oak Ridge National Lab., TN). pp 1-12 of In Basic aspects of freeze preservation of mouse strains. Stuttgart; Gustav Fischer Verlag (1976).

The utilization of low temperatures for the preservation of living cells poses two discrete questions: (1) How long can cells be held at low temperatures without undergoing deleterious change. (2) Is it possible to cool cells to the storage temperature and return them to the physiological range without damage. Those interested in the practicality of low-temperature storage most often raise the first question, but it is the second that contains most of the challenges. (auth)

3937 Generation of cytolytic T lymphocytes in vitro. VIII. Failure of anti-RS antisera to inhibit the generation of cytolytic T lymphocytes or cytolytic T lymphocyte activity. Fitch, F.W.; Ramseier, H. (Swiss Inst. for Experimental Cancer Research, Lausanne). *J. Immunol.;* **117**: No. 2, 504-510(Aug 1976).

Antibody reactive with recognition structures (RS) of mouse lymphoid cells for alloantigens (anti-RS) was prepared by immunization of F_1 hybrid mice with parental strain lymphoid cells or with antibody produced in one parental strain against alloantigens of the other parental strain. Such antisera prevented generation of the product of antigenic recognition (PAR) that is produced within a few hours in cultures prepared with a mixture of lymphoid cells from genetically disparate mice. However, treatment of responding lymphoid cells with anti-RS sera and complement did not inhibit generation of cytolytic T lymphocytes (CTL) in mixed lymphocyte cultures (MLC). Treatment of cells obtained from MLC with anti-RS sera and complement failed to inhibit cytolytic activity of such cells for specific alloantigens.

3938 Altered lymphocyte functions in rats bearing syngeneic moloney sarcoma tumors. I. Mitogen responses, mixed lymphocyte reactions (MLR) and mixed lymphocyte-tumor reactions (MLTR). Veit, B.C.; Feldman, J.D. (Scripps Clinic and Research Foundation, La Jolla, CA). *J. Immunol.;* **117**: No. 2, 646-654(Aug 1976).

Impairment of mitogen responses to Con A and LPS and of MLR and MLTR was detected in the spleens of rats bearing syngeneic Moloney sarcoma tumors. Depressed responses of both T cell and Ig+ cell populations were observed. During the observation period of 6 to 10 days post-tumor inoculation when maximal T cell-mediated cytotoxicity was observed in spleen and draining lymph node cells, spleen cells showed marked impairment in response to stimuli mentioned above. By contrast, draining lymph node cell activity was either unaltered or somewhat elevated above the level of activity measured in normal control populations. Data presented in this and an accompanying paper strongly indicate that macrophages are activated as immunosuppressor cells in tumor-bearing rats.

3939 Altered lymphocyte functions in rats bearing syngeneic moloney sarcoma tumors. II. Suppressor cells. Veit, B.C.; Feldman, J.D. (Scripps Clinic and Research Foundation, La Jolla, CA). *J. Immunol.;* **117**: No. 2, 655-660(Aug 1976).

Spleens from tumor-bearing rats contained a population of adherent cells that suppressed lymphocyte responses to Con A and LPS and cell-mediated cytotoxicity (CMC). By use of various fractionation procedures, Ig+ cells, T cells, and null cells were excluded as candidates for the suppressor cell activity. Procedures that removed macrophages abolished the suppressive activity whereas those procedures that enriched for or involved direct addition of macrophages resulted in augmented suppression. On the basis of these results, we conclude that the suppressor elements in spleens of tumor-bearing rats were macrophages.

PUBLIC HEALTH

3940 (DHEW/FDA—75-8007) **Standard technique for estimating patient exposure from photofluorographic x-ray machines.** Gaeta, N.A.; Burnett, B.M. (Bureau of Radiological Health, Rockville, Md. (USA)). Apr 1975. 19p. GPO.

Many different techniques have been used to measure exposures from photofluorographic x-ray machines. To evaluate patient radiation exposures and enable comparison of data from different machines, a standard technique for estimating patient exposure is recommended. Human chest exposures were evaluated using a copper sheet as the attenuating medium. Relationships are developed between patient and copper sheet exposures; details of the survey method are presented; x-ray machine problems and recommendations for correction are discussed. The method is applicable to 14 x 17 wall chest and other phototimed units.

3941 (DHEW/FDA—75-8017) **Application of automatic data processing techniques to selected diagnostic radiology operations.** Gitlin, J.N. (Bureau of Radiological Health, Rockville, Md. (USA)). Jun 1973. 151p. GPO.

Following a preliminary review of diagnostic radiology operations at the Johns Hopkins Hospital, in which several major activities were identified as amenable to automatic data processing (ADP) techniques, a pilot study of computer applications was undertaken with the cooperation and support of the National Center for Radiological Health. The pilot study was designed to test the feasibility of applying ADP techniques to the reporting of diagnostic radiology findings and to the control of x-ray film library transactions. The results of the pilot study demonstrated the feasibility of applying ADP techniques to the reporting of radiographic diagnoses with a significant reduction in the elapsed time associated with the x-ray consultation request-report cycle. The tests also provided a basis for evaluating the remote terminal configuration and the procedures developed to implement the systems design. In general, the findings were sufficiently encouraging to proceed with further development of the system, with the knowledge that specific modifications were required, particularly with regard to remote terminal devices, before the application of ADP techniques could be considered operational in diagnostic radiology.

AGRICULTURE AND FOOD TECHNOLOGY

REFER ALSO TO CITATION(S) 3351, 3881, 3915

3942 (RLO—2225-T19-35) **Three year progress report, July 1, 1972—June 30, 1975.** Cleland, R.E. (Washington Univ., Seattle (USA). Dept. of Botany). 1976. Contract AT(45-1)-2225-T19. 10p. Dep. NTIS $3.50.

Progress is reported on a study of the mechanism by which the plant hormone auxin regulates plant cell elongation. (CH)

BIOMEDICAL SCIENCES, APPLIED STUDIES

RADIATION EFFECTS ON BIOCHEMICALS

IN VITRO

REFER ALSO TO CITATION(S) 3963

3943 Radiology applied: mapping transcriptional organization in pro- and eukaryotes. Sauerbier, W. (Univ. of Colorado, Denver). pp 651-662 of In Radiation research. Biomedical, chemical, and physical perspectives. Nygaard, O.F. (ed.). New York; Academic Press, Inc. (1975).

From 5. international radiation research congress meeting; Seattle, Washington, USA (14 Jul 1974).

See CONF-740715—.

The effects of uv irradiation on the normal process of transcription following irradiation of template DNA was studied. The way in which these observations are used to provide us with a most powerful and widely applicable method of investigating the transcriptional organization of chromosomes is discussed. (ERB)

3944 Chemical changes induced in DNA by ionizing radiation and the relationship of their repair to survival of mammalian cells. Painter, R.B. (Univ. of California, San Francisco). pp 735-739 of In Radiation research. Biomedical, chemical, and physical perspectives. Nygaard, O.F. (ed.). New York; Academic Press, Inc. (1975).

From 5. international radiation research congress meeting; Seattle, Washington, USA (14 Jul 1974).

See CONF-740715—.

We still are ignorant of most of the details of DNA damage and repair that are necessary for determining the exact steps that lead to recovery after irradiation as well as the precise mechanisms by which radiation kills cells. From what is known, however, I am tempted to speculate that among the many kinds of lesions formed in mammalian DNA by ionizing radiation, certain ones have little or even no probability of being repaired. These may be of a kind that have both base damage and discontinuities in either or both DNA strands. It is possible that this kind of lesion—which, for example, might be a gap in the DNA with "sloppy" ends on one or both sides—is one with which the mammalian cell has rarely had to contend because, from its much more frequent encounters with longer wave length radiation, it has evolved mechanisms to repair damage of the kind typified by pyrimidine dimers. The cell repair systems, perhaps both excision and postreplicative, probably attempt to mend the damage, but the repair is either of poor fidelity or fails altogether. The end result, then, is a chromosome aberration that eventually leads to gene imbalance and cell death.

3945 Formation of nascent DNA molecules during inhibition of replicon initiation in mammalian cells. Painter, R.B.; Young, B.R. (Univ. of California, San Francisco). *Biochim. Biophys. Acta;* **418**: 146-153(19 Jan 1976).

X-irradiation of mammalian cells with moderate doses (100 to 1000 rads) inhibits the initiation of DNA replicons. This inhibition is observed as depressed amounts of radioactivity at low molecular weights when the DNA from the cells is analyzed by velocity sedimentation in alkaline sucrose gradients at 30 min after irradiation. There is no detectable effect on chain elongation and joining of those molecules that do initiate replication; this is indicated by the presence of the same amounts of radioactivity in nascent DNA molecules of high molecular weights from control and irradiated cells. The labeling of DNA molecules that initiated replication before irradiation continues unhindered for more than 60 min after irradiation, which is observed as peaks of radioactivity at high S values in alkaline sucrose gradients from irradiated cells. These data indicate that DNA replication in mammalian cells proceeds by continuous joining of nascent molecules that initiate almost simultaneously at origins at various distances from one another. Some of the interorigin distances are much greater than others, implying that large replicons make up a significant component of mammalian DNA. (auth)

IN MICROORGANISMS

3946 Psoralen cross-links in DNA: biological consequence and cellular repair. Cole, R.S.; Sinden, R.R. (Univ. of Georgia, Athens). pp 582-589 of In Radiation research. Biomedical, chemical, and physical perspectives. Nygaard, O.F. (ed.). New York; Academic Press, Inc. (1975).

From 5. international radiation research congress meeting; Seattle, Washington, USA (14 Jul 1974).

See CONF-740715—.

Psoralens, or furocoumarins, are a class of compounds particularly noted for their sensitizing action on organisms and nucleic acids in the presence of lung wavelength ultraviolet light. The molecular basis for the photosensitizing action of psoralens appears to be a consequence of their binding rather specifically to native DNA in the presence of light, forming adducts to single strands and interstrand cross-links. The role of cross-links in the repair of DNA is discussed. (ERB)

3947 Present status of DNA repair mechanisms in uv irradiated yeast taken as a model eukaryotic system. Moustacchi, E.; Waters, R.; Heude, M.; Chanet, R. (Institut du Radium, Orsay, France). pp 632-650 of In Radiation research. Biomedical, chemical, and physical perspectives. Nygaard, O.F. (ed.). New York; Academic Press, Inc. (1975).

From 5. international radiation research congress meeting; Seattle, Washington, USA (14 Jul 1974).

See CONF-740715—.

The repair mechanisms of altered DNA are generally less well understood for eukaryotes than they are for prokaryotes and bacteriophages. For mammalian cell lines cultured in vitro the specific labelling of DNA has allowed the biochemical analysis of some of the steps of the repair processes whereas the determination of their genetic controls is, with a few exceptions, obviously difficult. On the other hand, with fungi and more specifically with yeast taken as a model unicellular eukaryotic system, the genetic approach has been extensively explored: radiosensitive mutants are readily detected and genetically analyzed, double and multiple mutants can be constructed and from their responses to irradiation the number of repair pathways involved can be suggested. The lack of thymidine kinase in these organisms has hampered for a certain time the biochemical analysis of repair. However, the recent isolation of yeast strains capable of taking up and incorporating thymidine 5'-monophosphate into their DNA opens new possibilities for the future. In spite of this difficulty, attempts to measure the induction and removal of uv-induced pyrimidine dimers were performed by several groups during the last three years. The two main repair pathways described for E. coli, i.e., the excision-resynthesis and post-replicative recombinational repair pathways, do exist in yeast. The existence of the former pathway is supported not only by indirect evidence but also by biochemical analysis. The rad_1 and rad_2 mutants for instance have been shown to be blocked in the excision of uv-induced pyrimidine dimers. Other loci are epistatic to rad_1 and rad_2 (rad_3, rad_4) and are likely to act on this excision pathway. The genetic control of the mitochondrial response to a uv treatment involves nuclear genes and mitochondrial determinants. (ERB)

IN PLANTS

REFER ALSO TO CITATION(S) 3971

3948 (RLO—2221-T2-23) **Effect of ethylene and ionizing radiation on Saintpaulia peroxidase activity. Scientific paper No. 4333.** Warfield, D.L.; Nilan, R.A.; Witters, R.E. (Washington State Univ., Pullman (USA). Dept. of Agronomy and Soils). 1973. Contract AT(45-1)-2221. 18p. Dep. NTIS $3.50.

Ethylene gas and x rays, alone and in combination, were applied to petioles of Saintpaulia ionantha to test their effect on peroxidase activity. Both agents increased peroxidase activity, although ethylene was the most effective.

RADIATION EFFECTS ON CELLS

EXTERNAL SOURCE

3949 Repair studies at the molecular, chromosomal, and cellular levels: a review of current work in Japan. Okada, S. (Tokyo Univ.). pp 694-702 of In Radiation research. Biomedical, chemical, and physical perspectives. Nygaard, O.F. (ed.). New York; Academic Press, Inc. (1975).

From 5. international radiation research congress meeting; Seattle, Washington, USA (14 Jul 1974).

See CONF-740715—.

Repair mechanisms at the molecular, chromosomal, and cellular levels are studied. Current work on the subject in Japan is reviewed. (ERB)

3950 DNA damage and its repair in hyperthermic mammalian cells: relation to enhanced cell killing. Ben-Hur, E.; Elkind, M.M. (Hebrew Univ., Jerusalem). pp 703-717 of In Radiation research. Biomedical, chemical, and physical perspectives. Nygaard, O.F. (ed.). New York; Academic Press, Inc. (1975).

From 5. international radiation research congress meeting; Seattle, Washington, USA (14 Jul 1974).

See CONF-740715—.

Recently, it was reported that cultured mammalian cells are killed more readily under hyperthermia compared to normal conditions. In this presentation we summarize observations relative to the sensitizing effects of hyperthermia and several agents that are known to induce DNA damage. Correlations between cell killing and DNA damage and repair are noted, and the possible use of this approach in cancer therapy is discussed.

3951 Purified lesion-recognizing enzyme to assay DNA repair in cultured animal cells. Paterson, M.C. (Chalk River Nuclear Labs., Ontario). pp 718-726 of In Radiation research. Biomedical, chemical, and physical perspectives. Nygaard, O.F. (ed.). New York; Academic Press, Inc. (1975).

From 5. international radiation research congress meeting; Seattle, Washington, USA (14 Jul 1974).

See CONF-740715—.

The in vitro enzymatic assay, which utilizes a purified uv endonuclease as a dimer probe, not only complements existing assays for DNA repair, but also lends itself to a number of novel studies. In fact, preliminary data (unpublished) indicate that this assay may be gainfully employed to elucidate repair processes operating on a variety of physicochemical alterations in DNA including those induced by uv and ionizing radiations, as well as various chemical agents displaying mutagenic, carcinogenic, or teratogenic activity.

3952 Mammalian cell sensitization repair and the cell cycle. Sinclair, W.K. (Argonne National Lab., IL). pp 742-751 of In Radiation research. Biomedical, chemical, and physical perspectives. Nygaard, O.F. (ed.). New York; Academic Press, Inc. (1975).

From 5. international radiation research congress meeting; Seattle, Washington, USA (14 Jul 1974).

See CONF-740715—.

The effects of N-ethylmaleimide on the sensitization of HeLa cells following irradiation is discussed. The effects of this sensitization on the repair of damaged DNA in different stages of the cell cycle is also discussed. The author postulates the role of a factor Q in the repair process. (ERB)

3953 Chemical radiosensitization studies with mammalian cells growing in vitro. Chapman, J.D.; Dugle, D.L.; Reuvers, A.P.; Gillespie, C.J.; Borsa, J. (Whiteshell Nuclear Research Establishment, Pinawa, Manitoba). pp 752-760 of In Radiation research. Biomedical, chemical, and physical perspectives. Nygaard, O.F. (ed.). New York; Academic Press, Inc. (1975).

From 5. international radiation research congress meeting; Seattle, Washington, USA (14 Jul 1974).

See CONF-740715—.

The study of chemicals which can sensitize cells to the lethal action of ionizing radiation has proved useful in the elucidation of cellular radiation mechanisms. Those which selectively radiosensitize hypoxic cells could have a role, in combination with radiotherapy, in an improved treatment of some solid tumors. The scope of this paper is restricted to those compounds which appear to mimic the radiosensitizing action of molecular oxygen in mammalian cells and have come to be known as electron-affinic (EA) sensitizers.

3954 Vivo testing of hypoxic cell radiosensitizers. Rauth, A.M.; Kaufman, K.; Thomson, J.E. (Univ. of Toronto). pp 761-772 of In Radiation research. Biomedical, chemical, and physical perspectives. Nygaard, O.F. (ed.). New York; Academic Press, Inc. (1975).

From 5. international radiation research congress meeting; Seattle, Washington, USA (14 Jul 1974).

See CONF-740715—.

The problems encountered in the in vivo testing of hypoxic cell radiosensitizers are discussed. Among the problems involved in vivo are differential absorption, metabolism, or binding before reaching the hypoxic cell (tumor) area. Results of some in vivo tests are presented. (ERB)

RADIATION EFFECTS ON MICROORGANISMS

3955 (SAND—76-0231) **Beneficial Uses Program. Progress report, period ending March 31, 1976.** (Sandia Labs., Albuquerque, N.Mex. (USA)). Jul 1976. Contract E(29-1)-789. 54p. Dep. NTIS $4.50.

This is a comprehensive program to develop technologies for cost-beneficial uses of existing and future surplus radioactive materials. Major portion of the work was conducted in two subprograms: the waste resources utilization program and the separation technology and source development program. Purpose of the waste resources utilization program is to develop a technology to utilize ^{137}Cs as a γ source to sterilize sewage sludge for safe application as a fertilizer or as an animal feed supplement. Determinations were made of inactivation rates for Salmonella species, coliforms, and fecal strep in sewage sludge when radiation and thermoradiation were applied while bubbling O_2 through the sludge.

3956 Role of a retention medium in the irradiation treatment of wastewater. Eichholz, G.G.; Craft, T.F. (Georgia Inst. of Tech., Atlanta). *Trans. Am. Nucl. Soc.*; **23**: 109(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3957 Sandia waste resources utilization program. Sivinski, H.D. (Sandia Labs., Albuquerque, NM); Smith, G.S. *Trans. Am. Nucl. Soc.*; **23**: 109-110(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3958 Pathogen reduction and filterability enhancement in irradiated sewage sludge. Brandon, J.R. (Sandia Labs., Albuquerque, NM). *Trans. Am. Nucl. Soc.*; **23**: 110-111(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3959 Disinfection of municipal sludge by high-energy electrons. Trump, J.G.; Wright, K.A.; Sinskey, A.J.; Merrill, E.W.; Shah, D.N.; Danforth, J.L. (Massachusetts Inst. of Tech., Cambridge). *Trans. Am. Nucl. Soc.*; **23**: 111(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3960 Biological effects of high-energy electron irradiation of municipal sludge. Sinskey, A.J.; Shah, D.; Wright, K.A.; Trump, J.G. (Massachusetts Inst. of Tech., Cambridge). *Trans. Am. Nucl. Soc.*; **23**: 112(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3961 Radiation sources and costs for waste treatment processes. Cleland, M.R. (Radiation Dynamics, Inc., Westbury, NY). *Trans. Am. Nucl. Soc.*; **23**: 112(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

BASIC STUDIES

REFER ALSO TO CITATION(S) 3946, 3947

3962 (COO—2362-21) **Basic aspects of radiation action on microorganisms. Progress report, April 1, 1975—March 31, 1976.** Pollard, E.C. (Pennsylvania State Univ., University Park (USA)). Apr 1976. Contract E(11-1)-2362. 15p. Dep. NTIS $3.50.

Results of studies on the effects of irradiation on Escherichia coli showed that error-prone repair mutagenesis can be induced by ionizing radiation and uv light; induced single-strand DNA break repair has been confirmed and its characterization is in process; and there is clearly a separation between the induction of lambda and other phenomena. The dose-effect relationship differs and the phenomenon of radioresistance is removed. The action spectra for uv induced mutagenesis was plotted. (CH)

3963 (ORO—3631-6) **Radiation biophysicl study of biological molecules. Progress report, February 1, 1975—June 30, 1976.** Fluke, D.J. (Duke Univ., Durham, N.C. (USA)). 1976. Contract E(40-1)-3631. 17p. Dep. NTIS $3.50.

Progress is reported on the following research projects: direct action target investigation of molecular weights of enzymes exposed to fast electrons; direct action gamma radiation dosimetry with T_1 bacteriophage; uv radiation sensitivity of T_1 bacteriophage on various host strains of E. coli; temperature dependence of uv radiation direct action on dry T_1 bacteriophage; investigation of light and temperature effects during incubation of T_1 bacteriophage exposed to fast electrons; test of superoxide anion as a radiation intermediate in cellular radiobiology; uv action spectra related to error-prone repair; uv-reactivation experiments with T_1 and lambda bacteriophages; and split-dose uv mutagenesis in E. coli. (HLW)

3964 Comparison of germicidal activity of sunlight with the response of a sunburning meter. Billen, D.; Green, A.E.S. (Oak Ridge National Lab., TN). *Photochem. Photobiol.*; **21**: 449-451(1975).

In the present work, we compare germicidal activity of sunlight on strain AB 2480 with the irradiance of sunlight as measured with a Sunburning Ultraviolet Meter (manufactured by the Skin and Cancer Hospital, Temple University Health Sciences Center, Philadelphia, Pennsylvania). This instrument, an adaptation by Berger of one developed by Robertson (1972), uses a magnesium tungstate phosphor with a response approximating that of the erythema action spectrum. The light emitted by the phosphor is detected by a phototube which produces a proportional electric current, the signal used in these experiments. (auth)

3965 Rapid-mixing studies on the time-scale of radiation damage in cells. Adams, G.E. (Mount Vernon Hospital, Northwood, Eng.); Michael, B.D.; Asquith, J.C.; Shenoy, M.A.; Watts, M.E.; Whillans, D.W. pp 478-492 of In Radiation research. Biomedical, chemical, and physical perspectives. Nygaard, O.F. (ed.). New York; Academic Press, Inc. (1975).

From 5. international radiation research congress meeting; Seattle, Washington, USA (14 Jul 1974).

See CONF-740715—.

Rapid mixing studies were performed to determine the time scale of radiation damage in cells. There is evidence that the sensitizing effects of oxygen and other chemical dose-modifying agents on the response of cells to ionizing radiation involve fast free-radical processes. Fast response technique studies in bacterial systems have shown that extremely fast processes occur when the bacteria are exposed to oxygen or other dose-modifying agents during irradiation. The time scales observed were consistent with the involvement of fast free-radical reactions in the expression of these effects. (ERB)

3966 Genetic effects of uv on Escherichia coli: a model for prokaryotes. Bridges, B.A. (Univ. of Sussex, Brighton, Eng.). pp 626-631 of In Radiation research. Biomedical, chemical, and physical perspectives. Nygaard, O.F. (ed.). New York; Academic Press, Inc. (1975).

From 5. international radiation research congress meeting; Seattle, Washington, USA (14 Jul 1974).

See CONF-740715—.

The notion that base-pair substitution mutations induced by radiations arise as mistakes in repair was established by the work of Witkin who showed that Escherichia coli B strains believed to be deficient at the locus exr (now called exr A, or lexA in the K-12 family) were both more sensitive to uv and at the same time non-mutable by uv. Such bacteria were also non-mutable by γ-radiation and thymine starvation. It subsequently transpired that these strains (made by "one-step" mutagenesis) were not as genetically clean as had been believed, but near-isogenic strains made by transduction clearly confirmed Witkin's original conclusion. Since uv, ionizing radiation and thymine starvation cause mutations via the $exrA^+$ pathway, it was proposed this is an error-prone pathway capable of repairing single-strand gaps in DNA whether produced directly or indirectly.

FOOD PRESERVATION

3967 Understanding radiation energy and its use in the preservation of seafoods. Ronsivalli, L.J. (National Marine Fisheries Service, Gloucester, MA). *Mar. Fish. Rev.*; **39**: No. 6, 19-24(Jun 1976).

Some topics discussed are: the nature of radiation; radiation in the daily routine; penetration of radiation; radiation dosimetry; preservation of food; use of x and gamma radiation for preservation of seafood; and advantages of radiopreservation over heat-processing, freezing, and other methods of preserving seafoods. (HLW)

RADIATION EFFECTS ON PLANTS

BASIC STUDIES

3968 (COO—2283-7) Response of a forest ecotone to ionizing radiation. Progress report, October 15, 1975—October 14, 1976. Murphy, P.G.; Sharitz, R.R. (Michigan State Univ., East Lansing (USA); Savannah River Ecology Lab., Aiken, S.C. (USA)). Jun 1976. Contract E(11-1)-2283. 9p. Dep. NTIS $3.50.

Compositional and structural characteristics of three forest types, including aspen dominated, maple-birch dominated, and an intervening ecotone, were studied before and after irradiation in northern Wisconsin. A detailed analysis of the overall results obtained through 1975 is presented.

3969 Hypothesis explaining that carbon dioxide output is stimulated less by x-rays in leaf disks than in whole leaves. de Bock, F. (Grenoble-1 Univ., 38 (France)). *C. R. Hebd. Seances Acad. Sci., Ser. D*; **281**: No. 17, 1243-1246(27 Oct 1975). (In French).

The induced rise of carbon dioxide output following x irradiation is reduced in disks of Pelargonium zonale L. leaves, cut out before or after irradiation. There is a short lived rise when the lamina of leaves is scarified. Thus, it is possible that a volatile product responsible for the post-irradiation increase is released by tissues when epidermic wall is damaged: this product should be ethylene.

3970 Response of the desert shrub Krameria parvifolia after ten years of chronic gamma irradiation. Vollmer, A.T.; Bamberg, S.A. (California Univ., Los Angeles (USA). Lab. of Nuclear Medicine and Radiation Biology). *Radiat. Bot.*; **15**: No. 4, 405-409(Dec 1975).

A northern Mojave Desert shrub community was irradiated by a ^{137}Cs source for a ten-year period. Leaf and fruit production, cover, and percent live stem of Krameria parvifolia shrubs were found to respond significantly to a radiation gradient with exposure rates ranging from 0.1 to 10 R/day. Fruit and leaf production were greatly reduced at exposures over 6 R/day. Above 7 R/day 16% of the shrubs were dead compared to 1.2% in a non-irradiated area. Reduced cover, density and live stem values indicate a trend toward a lower status of Krameria in the community at cumulative exposures above 25 kR. Observations indicate that an equilibrium in response to irradiation has not yet occurred. Radiosensitivity of K. parvifolia is attributed in part to its phenology.

3971 The effect of ethylene and ionizing radiation on Saintpaulia peroxidase activity. Warfield, D.L.; Nilan, R.A.; Witters, R.E. (Washington State Univ., Pullman (USA)). *Radiat. Bot.*; **15**: No. 4, 423-429(Dec 1975).

Ethylene gas and x rays, alone and in combination, were applied to petioles of Saintpaulia ionantha Wendl. to test their effect on peroxidase activity. Both agents increased peroxidase activity, although ethylene was the most effective. X-ray treatment of petioles at five different peroxidase levels showed that as the initial activity of peroxidase increased the effect of a given dose of radiation decreased. Also, high doses, near the lethal limit for the species, were proportionately less effective in inducing peroxidase activity than were lower doses. Polyacrylamide disc electrophoresis showed no change in isozyme patterns with increases in peroxidase activity.

3972 Effects of gamma radiation on biomass production of ground vegetation under broadleaved forests of northern Wisconsin. Zavitkovski, J.; Salmonson, B.J. (Department of Agriculture, Rhinelander, Wis. (USA). North Central Forest Experiment Station). *Radiat. Bot.*; **15**: No. 4, 337-348(Dec 1975).

Effects of γ irradiation (10,000 Ci ^{137}Cs source) for one growing season on biomass production of ground vegetation under northern Wisconsin aspen and maple-aspen-birch forests and on an abandoned logging road were evaluated during and one year after irradiation. No significant changes in production were determined during the irradiation year. One year later three distinct zones - semi-devastated, herbaceous, and original forest - developed along the radiation gradient. Biomass production under forest canopies decreased significantly in the semi-devastated zone, increased significantly in the herbaceous zone (primarily responding to additional light), and remained unchanged under the original forest. Logging road vegetation responded similarly but the changes were restricted within higher radiation doses. At comparable levels of radiation, production of species of the logging road vegetation was affected less than that of species under forest canopies. Such a trend was predictable from the generally smaller interphase chromosome volumes, ICV's, of the species on the logging road and from their ability to survive in severe habitats.

RADIATION EFFECTS ON ANIMALS

MAN

REFER ALSO TO CITATION(S) 3730, 3815, 3819, 3940, 3941, 3996

3973 (DHEW/FDA—75-8020) Automation of scheduling and file room functions of a Diagnostic Radiology Department. Volume I. Lazarus, C.B.; Poitras, J.W.; Mitchell, W.P.; Knowlton, R.H.; Kaley, M.E.; Ianello, J.M.; Arenson, R.L.; Taveras, J.M.; Barnett, G.O. (Massachusetts General Hospital, Boston (USA)). Feb 1975. Contract FDA 72-71. 163p. GPO $2.35.

The automation of patient scheduling and file room functions of a diagnostic radiology department has been successfully accomplished at the Massachusetts General Hospital. Carried out under contract from the Bureau of Radiological Health, the pilot system includes scheduling, file room, and registration modules. The system has resulted in a reduction in delays in obtaining ex-

aminations and reports, and reduction in unnecessary radiation by allowing for the detection of possible duplicate, similar, or conflicting examinations. Film tracking ensures knowledge of the location of a master folder at all times.

3974 (DHEW/FDA—75-8024(Rev.)) **Gonad shielding in diagnostic radiology.** (California Univ., San Francisco (USA)). Jun 1975. Contract FDA 72-13. 24p. GPO.

The use of gonad shielding is an important radiation protection technique, intended to reduce unnecessary x-ray exposure of the gonads of patients from diagnostic x-ray procedures. This pamphlet will provide physicians and radiologic technologists with information which will aid their appropriate use of gonad shielding.

3975 (ORNL/TM—5453) **Mathematical description of a newborn human for use in dosimetry calculations.** Hwang, J.M.L.; Shoup, R.L.; Poston, J.W. (Oak Ridge National Lab., Tenn. (USA)). Sep 1976. Contract W-7405-eng-26. 50p. Dep. NTIS $4.00.

Estimating absorbed doses to children from external and internal radiation sources has become important to the nuclear industry and pediatric nuclear medicine. the design of mathematical representations of children of ages newborn, 1-year, and 5-years old, referred to as pediatric phantoms, establish a meaningful model for use in estimating radiation dose to children. The newborn (neonate) phantom is described. (CH)

3976 (ORNL/TM—5454) **Modifications and additions to the pediatric and adult mathematical phantoms.** Hwang, J.M.L.; Shoup, R.L.; Poston, J.W. (Oak Ridge National Lab., Tenn. (USA)). Sep 1976. Contract W-7405-ENG-26. 26p. Dep. NTIS $4.00.

Mathematical representations of humans one year, five years, and twenty years (adult) of age have been modified and are discussed in detail in the following sections. These modifications include the addition of a mandible and salivary glands in the head section and the inclusion of the gall bladder to the trunk region. These mathematical phantoms are undergoing continuous refinement in response to their increasing usefulness in absorbed radiation dose calculations for both external and internal emitters and diagnostic x-ray procedures.

3977 A calculation of external exposure in a uranium mine. Fourcade-Cancelle, N. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Service Technique d'Etudes de Protection et de Pollution Atmospherique). *Radioprotection;* **10**: No. 1, 11-28(1975). (In French).

The dose rate measured at the centre of a tunnel excavated in an ore at 1p. thousand of uranium was assessed to average 0.5mrad/h. This value was verified by calculations taking account of the source geometries and the main emitters of the uranium family. The dose rate from external exposure was calculated for two typical cases: in a cylindrical tunnel (length=50m, diameter:2m); in an open quarry 50m long, with a vertical wall, 2m high and a platform 8m wide. The dose rates were calculated close to the walls, taking account of the various γ and β radiation emitted either by the walls or by atmospheric radon or by the ore dust deposited on the skin. The calculated values were close to the measured values. The radiation contribution depends on the conditions of exposure; exposure is mainly due to γ radiation close to very thick wall whereas β radiation is prevailing in a contaminated atmosphere or in the case of skin contamination.

3978 Concept of human stem cell kinetics. Cronkite, E.P. (Brookhaven National Lab., Upton, NY). pp 780-787 of In Radiation research. Biomedical, chemical, and physical perspectives. Nygaard, O.F. (ed.). New York; Academic Press, Inc. (1975).

From 5. international radiation research congress meeting; Seattle, Washington, USA (14 Jul 1974).

See CONF-740715—.

The radiosensitivity of human stem cells is discussed. New techniques for the study of stem cell radiosensitivity are described. (ERB)

3979 Importance of proliferation kinetics and clonogenicity of tumor cells for volume responses of experimental tumors after irradiation. Hermens, A.F.; Barendsen, G.W. (Radiobiological Inst. TNO, Rijswijk, Netherlands). pp 834-849 of In Radiation research. Biomedical, chemical, and physical perspectives. Nygaard, O.F. (ed.). New York; Academic Press, Inc. (1975).

From 5. international radiation research congress meeting; Seattle, Washington, USA (14 Jul 1974).

See CONF-740715—.

It may be clear from this discussion that studies on the cell kinetics of tumors before and after treatment are of fundamental importance to the understanding of the clinical effect of radiotherapy. Knowledge of changes in cell kinetics induced by therapy may also have a great bearing on the development of combined radiotherapy and chemotherapy. However, the amount of cell kinetic data for both the normal and tumor tissue should be further enlarged in order to sort out successful combinations of therapy for different types of tumors.

3980 Implementing the requirement to reduce radiation exposure to 'as low as practicable' at the Lawrence Berkeley Laboratory. Thomas, R.H. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). *Health Phys.;* **30**: No. 3, 271-279(Mar 1976).

The work of the Health Physics Department of the Lawrence Berkeley Laboratory in limiting radiation exposures, over the past 25 yr, both to Laboratory personnel and the surrounding population, is reviewed. The radiation environments and the environmental impact of the four particle accelerators are discussed. Despite an increasing potential for the production of radiation with the beam intensity of the Bevatron increasing since its first operation in 1954, site boundary radiation levels have shown a steady decline since 1959. Estimates of population dose are described and shown to be comparable with the collective dose to radiation workers. The collective dose to personnel involved in accelerator operations and maintenance has shown a small decline. Cost effectiveness studies of shielding show that the cost of removing radiation exposure by providing a roof shield for the Bevatron has been $40 to 85 per man-rem. For the 88-in. cyclotron, projections over 10 yr estimate the cost of the provision of additional roof shielding to be between $200 and 450 per man-rem.

3981 U.S. Environmental Protection Agency's views on transportation of radioactive materials. Roe, W.D. (Environmental Protection Agency, Washington, DC). *Trans. Am. Nucl. Soc.;* **23**: 85(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

3982 Specific area gonad shielding. *Fed. Regist. (Wash., D.C.);* **41**: No. 143, 30327-30329(23 Jul 1976). (21CFR1000).

From Food and Drugs, 21CFR1000, Food and Drug Administration, Department of Health, Education, and Welfare—General. Radiation protection recommendations.

The Food and Drug Administration (FDA) is promulgating in final form voluntary recommendations to provide guidance for the use of specific area gonad shielding for patients undergoing x-ray examination. This amendment of Part 1000 is effective July 23, 1976.

VERTEBRATES

3983 (COO—3380-27) **Tumorigenic action of beta, proton, electron and alpha radiation in rat skin. Progress report, August 1, 1975—July 31, 1976.** Burns, F.J.; Albert, R.E. (New York Univ., N.Y. (USA)). 1976. Contract AT(11-1)-3380. 20p. Dep. NTIS $3.50.

The carcinogenic effect of ionizing radiation on rat skin was studied in an attempt to learn more about radiation carcinogenesis, especially how various parameters of the irradiation, such as dose distribution within the tissue and dose rate, affect the yield of tumors. It was found that when the dose was localized to a small region of skin, the tumor yield was reduced and the magnitude of the reduction indicated that the region of reduced response might extend about 150 μ into the irradiated zone. The proliferative state of the hair follicles at the time of irradiation had relatively little effect on tumor induction although old animals are less susceptible than young or newborn animals. The penetration requirement of at least 0.3 mm for producing tumors suggests that the hair follicle germ cells could be the oncogenic targets. The recovery rate for tumor induction measured by split-dose exposure protocols was 4 hours for electrons. Proton radiation exhibited nearly complete recovery at 24 hours PI. UVL promotion of electron induced tumors did not significantly alter tumor yields. Radioresistance to tumor induction appears to increase with age.

3984 (UR—3055-17) **Mechanisms of blood pressure changes following renal irradiation of intact, adrenalectomized and adrenal regenerating rats.** Rosenblum, M. (Rochester Univ., N.Y. (USA). Dept. of Radiation Biology and Biophysics). 1976. Contract E(11-1)-3055. 221p. Dep. NTIS $7.75.

Thesis.

Results are reported from studies on the differences in changes in systolic arterial blood pressure following renal x-irradiation (1100 R) in adrenal-intact, adrenalectomized, and adrenal-regenerating rats and the roles of the kidneys and of the adrenal glands in the blood pressure changes. (auth)

3985 Response of stem cell system to whole body and partial body irradiation. Gidali, J. (Joliot-Curie National Research Inst. for Radiobiology and Radiohygiene). pp 788-796 of In Radiation

research. Biomedical, chemical, and physical perspectives. Nygaard, O.F. (ed.). New York; Academic Press, Inc. (1975).

From 5. international radiation research congress meeting; Seattle, Washington, USA (14 Jul 1974).

See CONF-740715—.

The pluripotent stem cell system, though being distributed in the body, reacts homogeneously to irradiation. This homogeneity is controlled by short-range (local) and long-range (humoral) regulations acting primarily on pluripotent and committed stem cells. Migration of stem cells from unirradiated to irradiated areas may play a role in the regeneration processes even if local regeneration may also occur. Migration induction as well as proliferation induction in the shielded area do not seem to be specific radiation-induced reactions. Both may be influenced either by some physiological regulators released after irradiation in a higher quantity or by some non-specific triggering agents. Both repeated and continuous irradiation induce the establishment of a new steady state. In the steady state after repeated sublethal irradiations, the CFU count stays at a suboptimal level either as a consequence of an increased differentiation or of some undefined damage in milieu control. In the new steady state during continuous irradiation, the number of mature elements in blood is close to the normal while CFU population is reduced to less than 2 percent of its original level.

3986 Characteristics of the stem cell population surviving a sublethal exposure to ionizing radiation. Duplan, J.F. (INSERM, Bordeaux). pp 797-807 of In Radiation research. Biomedical, chemical, and physical perspectives. Nygaard, O.F. (ed.). New York; Academic Press, Inc. (1975).

From 5. international radiation research congress meeting; Seattle, Washington, USA (14 Jul 1974).

See CONF-740715—.

The main and most undisputable effect of radiation on the stem cell pool is the shift of the differentiation pattern towards the granulocytic and megacaryocytic series. This is a transient phenomenon which lasts for about 7 to 10 days and is concomitant with an increase in D_0, TE, and replication rate. For this reason it would be reasonable to assume that quantitative characteristics reflect the specific properties of this surviving stem cell population. Whether these changes depend on actual kinetics or on an artifact of the assay is a controversial matter. At this point it must be stressed that whereas stem cells which are localized in the spleen seem to escape the microenvironmental control, those that seed the BM do not exhibit significant changes.

3987 Cell proliferation changes in hemopoietic tissue as a result of irradiation or drug administration: the control of cell proliferation in hemopoietic tissue. Lord, B.I. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). pp 826-833 of In Radiation research. Biomedical, chemical, and physical perspectives. Nygaard, O.F. (ed.). New York; Academic Press, Inc. (1975).

From 5. international radiation research congress meeting; Seattle, Washington, USA (14 Jul 1974).

See CONF-740715—.

The nature of the control processes operative on these cells is not completely understood. Erythropoietin has long been known as a direct stimulator of erythropoiesis at all levels. A similar compound has long been sought (unsuccessfully) to stimulate granulopoiesis. Currently the role of specific proliferation inhibitors of erythropoiesis and granulopoiesis are now attaining more prominence. In this respect, Patt and Maloney demonstrated an inverse relationship of cell concentration in the rabbit femur and the uptake of tritiated thymidine by the cells, and we have now established that extracts of mature blood cells do have specific effects on developing hemopoietic cells which are compatible with proliferation inhibition and which are completely reversible. Our current studies are showing that, used in vivo, these extracts are in fact capable of lowering the proliferation rates of the maturing hemopoietic cells (Lord- unpublished results). It is clear, therefore, that the maturing cell populations proliferate under a complex set of control processes.

3988 T cell requirement for experimental allergic encephalomyelitis induction in the rat. Ortiz-Ortiz, L.; Nakamura, R.M.; Weigle, W.O. (Scripps Clinic and Research Foundation, La Jolla, CA). *J. Immunol.*; **117**: No. 2, 576-579(Aug 1976).

The question of whether a cell-mediated or a humoral mechanism initiates EAE in rats sensitized with BP-CFA was investigated. The requirement of T cells for EAE induction was manifested when Tx irradiated rats were reconstituted with normal lymphoid cells treated with ATS and then injected with BP-CFA. Neither EAE nor antibody was produced, indicating the T cell dependency of BP specific antibody production. More precise information regarding the role of the T cell in the production of EAE was obtained by means of passive transfer of EAE with sensitized lymphocytes. Thus, transfer of lymphoid cells from rats previously sensitized to BP-CFA into Tx irradiated rats elicited EAE and antibodies to BP. However, no EAE followed when the transferred cells were first depleted of T cells by treatment with ATS. Nevertheless, ATS pretreatment did not depress the levels of antibody to BP produced in the transfer recipients. The latter finding indicates that the cells from animals sensitized 9 days previously were already committed to the production of antibodies to BP. Therefore, T cells are absolutely necessary for induction of EAE and antibody detected by antigen-binding is not responsible for the pathogenesis of this disease.

3989 Radioprotection of mice by phenylhydrazine-damaged erythrocytes. Smith, L.H.; McKinley, T.W. Jr. (Oak Ridge National Lab., TN). *Radiat. Res.*; **67**: No. 2, 286-298(Aug 1976).

Erythrocytes (RBC) from mice given phenylhydrazine are protective when injected into syngenic mice before x irradiation. The LD/sub 50/30/ was increased about 90 R when these RBC (PhRBC) were given iv 1 day before exposure. PhRBC were not protective when given 4 hr after irradiation. Radioprotection by PhRBC did not appear to result from either an increase in the radioresistance (D_0) of hemopoietic stem cells or an increase in number of stem cells at risk at the time of irradiation. Using blood clearance and liver accumulation of labeled sheep RBC as a measure of reticuloendothelial activity, we found no evidence that a stimulated reticuloendothelial system was responsible for radioprotection by PhRBC. Some evidence suggested that repair of hemopoietic stem cells was enhanced in mice injected with PhRBC before x irradiation.

3990 Radiation-induced changes in the fine structure of the heart: comparison of fission neutrons and ^{60}Co γ rays in the mouse. Yang, V.V.; Stearner, S.P.; Tyler, S.A. (Argonne National Lab., IL). *Radiat. Res.*; **67**: No. 2, 344-360(Aug 1976).

The ultrastructural changes in mouse cardiac muscle and cardiac vasculature from 4 days to 1 yr after irradiation are described. Radiation treatment consisted of single-dose, total-body exposures to 240 rad fission neutrons or 788 rad ^{60}Co γ rays. Cardiac muscle showed areas of focal myofibrillolysis, myofibrillar degeneration with loss of entire myofibrils, presence of lipid bodies and of lysosomal-like bodies, and partially vacuolated mitochondria in some myocytes. There was apparently no Z-band thickening or disruption. Intercalated disks were sometimes dissociated and interstitial fibrosis was occasionally seen surrounding myocytes. The cardiac microvasculature showed progressive degenerative lesions, including swollen endothelial cells, cytoplasmic blebs and extensions, myelinlike figures, vacuolated mitochondria, and thrombi that adhered to irregularities of the endothelial surface. After both forms of irradiation, smooth muscle degeneration and fibrosis in coronary arteries first appeared at 3 months and became progressively more severe at 6 and 12 months. Quantitative estimations of myofibrillar and capillary degeneration revealed that damage was most severe at 1—3 months in both neutron- and gamma-irradiated groups. At 12 months, significant capillary degeneration was still present, but the condition of the myofibrils was comparable to that in controls. Quantitative differences between neutron- and gamma-irradiated groups were not statistically significant.

BASIC STUDIES

3991 Radiation-induced cleavage delay in Chaetopterus eggs. Viswanathan, G.; Rustad, R.C. *Biol. Bull.*; **149**: No. 2, 449(Oct 1975).

X-irradiation of either the eggs or the sperm of sea urchins is known to lead to mitotic delay which, over a wide range of doses, is proportional to the logarithm of the exposure. Similarly, sea urchin eggs exhibit a uv-induced mitotic delay which is exponentially dependent on dose. Exposure of either the eggs or sperm of Chaetopterus pergamentaceus to γ-radiation results in a cleavage delay which is proportional to the logarithm of the dose. The sperm are significantly more sensitive than the eggs. This observation contrasts with our data on Arbacia which indicate identical sensitivities of the gametes at low doses and a hypersensitivity of the eggs at high ones. Ultraviolet irradiation of Chaetopterus sperm leads to a cleavage delay which is proportional to the logarithm of the dose. In contrast, the uv dose-dependence of the eggs is linear. There is a postfertilization increase in uv-sensitivity followed by a biphasic loss of sensitivity. Sea urchin eggs exhibit a similar pattern of sensitivity changes to γ-radiation; however, the uv pattern differs. There is a uv-sensitivity plateau followed by a linear loss of sensitivity. The differences between the responses of these two animals may provide a useful framework for the future analysis of the radiation sensitive mitotic events. (auth)

RADIONUCLIDE EFFECTS - INTERNAL SOURCE

MAN

REFER ALSO TO CITATION(S) 3819, 3975, 3976, 3981

3992 (LA-UR—76-1718) **Calibration procedures for in-vivo sodium iodide spectrometry of plutonium and americium in the human lungs.** Umbarger, C.J.; Jett, J.H. (Los Alamos Scientific Lab., N.Mex. (USA)). 1976. Contract W-7405-ENG-36. 18p. (CONF-760634—5). Dep. NTIS $3.50.

From Pacific regional symposium; Seattle, Washington, United States of America (USA) (24 Jun 1976).

This paper described the calibration techniques and associated error analysis for the in-vivo measurement by NaI spectrometry of heavy elements in the lung of personnel, specifically ^{238}Pu, ^{239}Pu and ^{241}Am. A very brief description of the instrumentation system is included.

3993 (ORP/CSD—75-3) **Radioactivity distribution in phosphate products, by-products, effluents, and wastes.** Guimond, R.J.; Windham, S.T. (Environmental Protection Agency, Washington, D.C. (USA). Office of Radiation Programs). Aug 1975. 39p. Environmental Protection Agency, Washington, DC.

Phosphate rock throughout the world contains uranium in concentrations ranging from a few ppM to a few hundred ppM. In the United States, phosphate rock normally contains between 100 to 150 ppM uranium. Mining and processing of these ores redistributes much of the uranium daughters among the various products, by-products, and wastes. These materials are then widely dispersed throughout the environment. This redistribution may lead to increased exposure of the public to these naturally-occurring radionuclides. In determining the magnitude of the population exposure caused by this redistribution and in developing environmental standards and controls to prevent contamination of the biosphere from these naturally-occurring radionuclides it is necessary to determine the concentrations and total quantities of these radionuclides in the products, by-products, effluents and wastes of phosphate mining and manufacturing. Samples of phosphate ores, products, by-products, effluents, and wastes were obtained and analyzed for their radioactivity content. Quantities of radioactivity entering the environment through various products, by-products, effluents, and wastes were estimated.

3994 (ORP/CSD—75-4) **Preliminary findings radon daughter levels in structures constructed on reclaimed Florida phosphate land.** (Environmental Protection Agency, Washington, D.C. (USA). Office of Radiation Programs). Sep 1975. 38p. Environmental Protection Agency, Washington, DC.

Preliminary results are reported from a survey of the radon daughter levels in structures in Polk County, Florida, built on reclaimed phosphate tailings containing various amounts of ^{226}Ra. The structures surveyed consisted primarily of private dwellings although a few office buildings were also surveyed. Track-etch films and TLD air samplers were used to measure the levels of radon daughters within the structures and in structures built on non-phosphate land. Radiation levels were converted to WL units (the working level (WL) unit is defined as the potential α energy from the short-lived daughters of Rn which will produce 1.3×10^5 MeV in one liter of air). The highest observed level in any structure was 0.2 WL. Possible health hazards to long-time occupants are discussed. (CH)

3995 (UCRL—78409) **LLL plutonium lung counter calibration and discussion of errors.** Anderson, A.L.; Campbell, G.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 20 Jul 1976. Contract W-7405-Eng-48. 19p. (CONF-760634—4). Dep. NTIS $3.50.

From Pacific regional symposium; Seattle, Washington, United States of America (USA) (24 Jun 1976).

The Whole Body Counter at Lawrence Livermore Laboratory is located in a shielded room 6.1 metres underground, and is equipped with a filtered air supply to remove approximately 99 percent of the radioactivity present from radon-thoron daughters in the air. Two Harshaw Phoswich detectors 120 mm in diameter are presently used for lung counting. An Alderson Remab phantom is used for calibration. This is a take-apart phantom which has a human skeleton and fillable compartments to simulate the body organs. The lung cavities can be filled with lung-equivalent material containing radioactive standards for calibration. Several uniformly loaded sets of these lungs have been made incorporating various isotopically pure radionuclides including ^{238}Pu, ^{239}Pu, and ^{241}Am.

3996 **Year 2000 estimated population dose for the Tennessee Valley region.** Fletcher, J.F. (Hanford Engineering Development Lab., Richland, WA); Strauch, S.; Siegel, G.R.; Witherspoon, J.P. *Trans. Am. Nucl. Soc.*; **23**: 85-86(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

NUCLIDE KINETICS AND TOXICOLOGY

MAN

REFER ALSO TO CITATION(S) 3083, 4015

ANIMALS

REFER ALSO TO CITATION(S) 3841

3997 (BNWL—2056) **Biology of the transuranium elements: an indexed bibliography.** Thompson, R.C. (comp.). (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Jul 1976. Contract E(45-1)-1830. 238p. Dep. NTIS $8.00.

This bibliography on the biology of the transuranium elements is a revision of one issued in 1973 (BNWL-1782). It includes essentially all of the citations from the earlier document, a few corrections and additions from the older literature, plus the new literature to mid-1975. It also includes a subject-matter index not present in the original document.

3998 **Decorporation of ^{241}Am from mouse bone using Zn-DTPA and parathyroid hormone.** Fisher, D.R.; Mays, C.W.; Dockum, J.G. (Utah Univ., Salt Lake City (USA). Radiobiology Div.). *Health Phys.*; **30**: No. 3, 313-315(Mar 1976).

Brief note.

PLANTS

REFER ALSO TO CITATION(S) 3841

3999 **Deuterium isotope effects in Nicotiana tabacum.** Uphaus, R.A.; Blake, M.I.; Katz, J.J. (Argonne National Lab., IL). *Can. J. Bot.*; **53**: No. 19, 2128-2133(1 Oct 1975).

The effects of increasing concentrations of heavy water on the growth, development, morphology, and transpiration patterns in Nicotiana tabacum L. were studied throughout the life cycle of the plant. The higher deuterium levels caused a marked reduction in size and flowering, together with extensive tissue necrosis. These observations are consistent with the literature on the effects of deuterium on plant development. The present study showed a deleterious effect of deuterium on alkaloid production, associated with heightened transpiration rates and decreased fractionation of carbon isotopes in photosynthesis. All of the observed effects are consistent with the established view of deuterium as a nonspecific chaotropic agent, whose effects are evident at every level of plant organization.

MICROORGANISMS

REFER ALSO TO CITATION(S) 3841

THERMAL EFFECTS

INVERTEBRATES

REFER ALSO TO CITATION(S) 3871

4000 (ORNL-tr—4160) **Stable and fluctuating temperature. II. Comparison of the effect on the duration of intermolting of Gammaridae females.** Roux, A.L. 1974. Translation by M. Gerrard of French report. 12p. Dep. NTIS $3.50.

Experiments were carried out on two closely related species of freshwater gammarids Gammarus pulex and G. fossarum. The intermoult duration of adult females was determined at the constant temperatures of 5°C, 10°C, and 15°C on one hand, and at a temperature which fluctuated rhythmically and daily between 5°C and 15°C, on the other hand. Whatever the breeding temperature, the mean intermoult duration of G. fossarum females was always longer than that of G. pulex females. Under constant conditions, and for each temperature increase of 5°C, the intermoult duration of the two species was approximately twice shorter. When compared with the 10°C constant level, or with the computed time determined from the hourly proportion of development occurring at 5°C, 10°C, and 15°C constant levels, fluctuating temperatures have a significant accelerating effect on the moulting process.

VERTEBRATES

REFER ALSO TO CITATION(S) 3871, 3877

CHEMICALS METABOLISM AND TOXICITY

REFER ALSO TO CITATION(S) 3880

4001 Environmental impact of cadmium: an overview. Hiatt, V.; Huff, J.E. *Int. J. Environ. Stud.;* **7**: 277-285(1975).

This overview of the impact of cadmium upon the environment has been drawn from the recent research literature and from review articles. This review highlights those aspects of both the present and potential environmental problems of cadmium. Emphasized are properties and analyses; environmental processes; biological aspects of microbial, plant, animal, and human life; and "safe" levels of exposure. (auth)

4002 Design and calibration of a low speed windtunnel for studying the foliar deposition and uptake of aerosols. Craig, D.K.; Klepper, B.L. (Battelle Pacific Northwest Labs., Richland, WA). *Am. Ind. Hyg. Assoc. J.;* **36**: No. 9, 692-699(Sep 1975).

A 2.75 m-long (9 ft.) windtunnel facility to deliver highly toxic aerosols to the foliage of terrestrial plants under safe and well-characterized conditions is described. Flow velocities of 0.1 to 25 cm/sec in the 930 cm^2 (1 ft^2) cross-section experimental area are attainable. Calibration of this facility using a ^{198}Au-labelled colloidal gold aerosol is presented. (auth)

4003 Biochemical changes in rat kidney on exposure to elemental mercury vapor: effect on biosynthesis of metallothionein. Cherian, M.G.; Clarkson, T.W. (Univ. of Rochester, NY). *Chem.-Biol. Interact.;* **12**: No. 2, 109-120(Feb 1976).

Evidence is presented that exposure of rats to elemental mercury vapor results in increased amounts of a metallothionein-like protein in kidney tissue but not in liver. After three or more daily exposures, each of 2 h duration, to elemental mercury vapor, more than 50 percent of the mercury in kidney tissue is bound to a protein having a molecular weight (mol. wt.) of about 10,000 as determined by Sephadex G-75 gel filtration chromatography. Cystine is incorporated into a 10,000 mol. wt. protein fraction from kidneys of rats which were injected with [U-^{14}C] cystine after five daily 2-h exposures to mercury vapor. In contrast, no significant incorporation of [U-^{14}C] cystine into this protein fraction was observed in kidneys of control rats or in livers of both control and mercury vapor-exposed rats. The in vivo incorporation of ^{109}Cd into the fraction followed the same pattern as that of [^{14}C] cystine in rats injected with tracer doses of $CdCl_2$ labeled with radioactive ^{109}Cd isotope. This 10,000 mol. wt. protein, newly synthesized in response to repeated exposures to mercury vapor, exhibited identical properties to metallothionein, namely in its subcellular localization, molecular weight, heat stability and isoelectric points. A significant incorporation of [U-^{14}C] cystine into this protein in rat kidney alone on exposure to mercury vapor confirms its induced biosynthesis in the kidney.

4004 Humoral antibody response in mice after single dose exposure to lead or cadmium. Koller, L.D.; Exon, J.H.; Roan, J.G. (Oregon State Univ., Corvallis). *Proc. Soc. Exp. Biol. Med.;* **151**: No. 2, 339-342(Feb 1976).

Mice were given single doses of 4 mg of lead or 0.15 mg of cadmium, either intraperitoneally (IP) or orally by intubation. Eight hours later all mice were inoculated IP with 0.2 ml of a 2 percent suspension of sheep red blood cells (SRBC). Mice from each group were killed on days 3-6 to measure primary immune response (19s or IgM antibody) and on days 8-11 for the secondary response (7s or IgG antibody) after a second inoculation of SRBC on day 7. Lead administered orally or IP stimulated IgM antibody. Cadmium caused an increase in IgM when injected IP but resulted in a slight decrease when given orally. Lead, orally or IP, significantly reduced IgG antibody, but the IgG response decreased only when cadmium was given orally, and increased when injected IP. (JTE)

CELLS

REFER ALSO TO CITATION(S) 4007

4005 (ORNL-tr—4204) **Bactericidal action. II. Action of alkyl halides on bacterial spores.** Endres, G.; Hammer, F.; Rohr, E. Translated by R.G. Mansfield and M. Gerrard from *Justus Liebigs Ann. Chem.;* **559**: 42-48(1948). 6p. Dep. NTIS $3.50.

Studies on pure cultures of Bacillus mesentericus spores showed that the sporicidal action of four halide compounds active in the presence of sodium carbonate increases in the series propyl bromide, ethyl iodide, allyl bromide, crotyl chloride. Thus if the effect of the acid is eliminated, i.e., the alcohol solution washing the spores is practically acid-free, a clear relation between the germ-killing power and the halogen mobility is present. The total results seem to have a consistent meaning. The alkyl halides enter into the spores assuming that the vapor pressure is high enough at the temperature observed (60°C) and the decisive reaction which results in germ destruction is the hydrolytic splitting of the halide within the spore, its destruction in alcohol and the halogen acids.

MICROORGANISMS

REFER ALSO TO CITATION(S) 3863

PLANTS

REFER ALSO TO CITATION(S) 3839

4006 (ORNL-tr—4111) **Promotion of growth in lower and higher plants by carcinogenic polycyclic aromatics.** Graef, W.; Nowak, W. Translated by H. Tobias from *Arch. Hyg. Bakteriol.;* **150**: 513-528(1966). 16p. Dep. NTIS $3.50.

The effect of fluoranthene, 1.12-benzoperylene, 3.4-benzofluoranthene, indeno(1.2.3.-cd-)pyrene, 1.2-benzoanthracene, 3.4-benzopyrene and 1.2.5.6-dibenzo-anthracene on the growing of alga cultures (chlorella vulgaris, scenedesmus obliquus, ankistrodesmus oraunii) and on soil and hydrocultures of higher plants (tobacco, rye, radish) are tested in a series of examinations. The mentioned substances were applied in the nutrient solutions or in the water, in concentrations of 10 to 20 litre, using 1 γ/litre of polyethyleneglycol (molecular weight of 200) as a solution carrier. All substances had growth-promoting effects on plants, 3.4-benzopyrine having been the most effective one. The degree of efficiency of the other substances corresponded essentially to their carcinogenic activity.

4007 Sulfur damage to Douglas-fir near a pulp and paper mill in western Montana. Carlson, C.E. Missoula, MT; Department of Agriculture (Apr 1974). 42p.

Serious needle browning, not caused by parasitic fungi or insects, occurred on Douglas-fir over 5200 acres of forested lands during the winter of 1972-73 near a paper and pulp mill at Missoula, Montana. Severity of the damage increased at decreasing distance from the mill; and total foliar sulfur content ranged from .00 to .63 in the area, with highest concentrations found in the most severely affected locations. Average sulfation rate was 1.52 mg sulfur trioxide/sq cm/day in the severely affected area and .96 mg SO_3/sq cm/day in a lightly affected area. Plant symptoms as a whole were similar to those caused by excessive airborne sulfur compounds. Histological analyses of affected foliage showed the mesophyll cells to be affected first (plasmolysis and collapse), followed by hypertrophy and collapse of parenchyma in the vascular system.

4008 Effect of serotonin on cyclic nucleotides of human platelets. Agarwal, K.C.; Steiner, M. (Brown Univ., Providence). *Biochem. Biophys. Res. Commun.;* **69**: No. 4, 962-969(19 Apr 1976).

Serotonin produced a 6 to 10 fold increase of cyclic GMP over baseline levels of this nucleotide in platelets. Maximum stimulation was reached within 30 sec to 1 min after addition of serotonin and was dependent upon its concentration in the medium. Inhibition of serotonin uptake by methysergide, dihydroergotamine and chloroimipramine did not influence the serotonin-induced stimulation of cyclic GMP but glutaraldehyde and formaldehyde blocked it completely. Cyclic AMP levels in platelets were not affected by serotonin. The serotonin-induced stimulation of cyclic GMP is independent of the uptake of this biogenic amine by platelets and is not due to platelet aggregation.

4009 Induction by ethylene of cyanide-resistant respiration. Solomos, T.; Laties, G.G. (Univ. of California, Los Angeles). *Biochem. Biophys. Res. Commun.;* **70**: No. 2, 663-671(17 May 1976).

Ethylene and cyanide induce an increase in respiration in a variety of plant tissues, whereas ethylene has no effect on tissues whose respiration is strongly inhibited by cyanide. It is suggested that the existence of a cyanide-insensitive electron transport path is a prerequisite for stimulation of respiration by ethylene.

INVERTEBRATES

4010 (RLO—2227-T12-56) **PCB and the activities budget of the crab Hemigrapsus oregonensis.** Pearson, W.H.; Holton, R.L. (Oregon State Univ., Corvallis (USA). School of Oceanography). 1974. Contract AT(45-1)-2227. 22p. Dep. NTIS $3.50.

In order to understand the adaptive processes of an estuarine organism under stress from a pollutant the behavior of the crab Hemigrapsus oregonensis was assessed with and without exposure to polychlorinated biphenyls (PCB'S). Activities budgets were developed from observations of the time crabs spent in 20 categories of shelter use, posture, and activity while held in habitat models complete with tides. Females spent more time sheltered and feeding but less time displaying than males. For both sexes certain activities predominated at certain tidal stages. Multivariate discriminant analysis was used to explore differences in activities budgets between ordinary conditions and stressing conditions when PCB-contaminated sand was present. Discriminant functions containing all 20 activities did not clearly distinguish the budgets of stressed and unstressed crabs. Stepwise discriminant analyses, used to choose the most parsimonious functions, indicated where the budgets differed. For both sexes and different trials, feeding consistently appeared in the multivariate discriminant functions and decreased under PCB exposure. The discriminant analysis suggested that the consequences one would predict for a pollutant-induced stress are functions of the paradigm under which one observes. In a search to predict the consequences of pollution one should be alert not only to the character of the organism's failures, but also to the nature of its successes.

VERTEBRATES

REFER ALSO TO CITATION(S) 3877, 3919, 3932

4011 Nuclear ^{115}Cd: uptake and disappearance correlated with cadmium-binding protein synthesis. Bryan, S.E.; Hidalgo, H.A. (Univ. of New Orleans). *Biochem. Biophys. Res. Commun.*; **68**: No. 3, 858-866(9 Feb 1976).

The intracellular distribution of ^{115}cadmium was determined following a pulsed exposure to the metal. The uptake and disappearance of label from rat liver nuclei was correlated with the appearance of a cytoplasmic Cd-binding protein. By coupling in vivo-in vitro experiments it was shown that unspecifically bound cadmium is free to enter the nucleus while specifically bound cadmium remains in the cytoplasm.

4012 Hemodynamic effects of aerosol propellants. III. Vascular resistance in the canine hind limb. Simaan, J.A.; Aviado, D.M. (Univ. of Pennsylvania, Philadelphia). *Toxicology*; **5**: No. 3, 287-295(Mar 1976).

The aerosol propellants trichlorofluoromethane (FC 11) dichlorofluoromethane (FC 12), dichlorotetrafluoroethane (FC 114) and methyl chloroform were tested for hypotension effects due to a vasodepressor component of action in dogs. One hind limb of the dogs was perfused at constant flow through the femoral artery with 5 percent FC 11, 20 percent FC 12, 20 percent FC 114 and 1 percent methyl chloroform. The mean aortic pressure was lowered by 22 percent, 6 percent, 15 percent, and 17 percent, respectively. After vagotomy only FC 11 and methyl chloroform decreased mean aortic pressure to levels significantly lower than those observed in intact preparations. Vascular resistance of the perfused limb decreased in intact preparations only after methyl chloroform (—12 percent), but in vagotomized preparations it decreased after all 4 agents (FC 11, —17 percent; FC 12, —10 percent; FC 114, —16 percent; methyl chloroform, —18 percent). FC 11, FC 12, and FC 114 exhibited a vasodepressor effect which was evident in the absence of reflex activity, but which was readily overcome by the constrictor action of the reflexly-induced activation of the sympathetic system. Methyl chloroform exhibited a vasodepressor activity in intact preparations probably because of concomitant depressant action on carotid-aortic reflex mechanisms through its anesthetic action. (JTE)

4013 Epithhelial lesions induced by N-nitrosoheptamethyleneimine in host and transplanted rat treacheas. Taylor, H.W.; Kendrick, J.; Griesemer, R.A.; Nettesheim, P. (National Cancer Inst., Washington, DC). *J. Natl. Cancer Inst.*; **57**: No. 2, 339-341(Aug 1976).

N-Nitrosoheptamethyleneimine (NHMI) was given by gastric intubation, at a dosage of 10 mg/kg body weight twice weekly for 5-20 weeks, to F344 rats bearing subcutaneous tracheal transplants. Groups of 5 rats were killed at 5, 10, 15, and 20 weeks, and 1 group was killed at week 33 of the experiment (13 weeks after the last NHMI dose). Sequential changes in host tracheas consisted of hyperplasia with complete loss of mucociliary epithelium, squamous metaplasia, intense mononuclear infiltration, reestablishment of mucociliary epithelium (during the course of NHMI administration) except for focal areas of hyperkeratotic squamous metaplasia or marked dystrophic changes, and finally, papillomas, polyps, and invasive squamous cell carcinomas. Lesions in tracheal transplants consisted mostly of atrophic and dystrophic changes, with only a few small foci of squamous metaplasia and no neoplastic changes.

MAN

REFER ALSO TO CITATION(S) 3931, 4015

HEALTH AND SAFETY

4014 (CONF-760811—2) Radiological safety considerations in the design and operation of the ORNL Transuranium Research Laboratory (TRL). Haynes, C.E. (Oak Ridge National Lab., Tenn. (USA)). 1976. Contract W-7405-eng-26. 22p. (SM—209/34). Dep. NTIS $3.50.

From Symposium on the design of and equipment for hot laboratories; Otaniemi, Finland (2 Aug 1976).

The Transuranium Research Laboratory (TRL) is the central facility at Oak Ridge National Laboratory (ORNL) for chemical and physical research involving transuranium elements. Transuranium Research Laboratory investigations are about equally divided between studies of inorganic and structural chemistry of the heavy elements and nuclear structure and properties of their isotopes. Elements studied include neptunium, plutonium, americium, curium, berkelium, californium, and einsteinium, each in microgram-to-gram quantities depending upon availability and experimental requirements. This paper describes an eight-step safety procedure followed in planning and approving individual research projects. This procedure should provide an optimum margin of safety and should permit the accomplishment of successful research.

4015 (LA-NUREG—6427-PR) Respirator studies for the Nuclear Regulatory Commission. Progress report, July 1, 1974—June 30, 1975. Hack, A.L.; Moore, T.O.; Revior, W.H. (Los Alamos Scientific Lab., N.Mex. (USA)). Jul 1976. Contract W-7405-ENG-36. 6p. Dep. NTIS $3.50.

Major accomplishments during FY75 were training NRC personnel in the principles of respiratory protection, preparing video tapes explaining respiratory protection aspects of NRC Guides, publishing a newsletter of current happenings in respiratory protection, organizing a respiratory symposium, producing and NRC manual of respiratory protection, and initiating a study to define protection factors of air-supplied hoods.

4016 Reliability analysis of phased missions. Esary, J.D.; Ziehms, H. (Naval Postgraduate School, Monterey, CA). pp 213-236 of In Reliability and fault tree analysis. Barlow, R.E. (ed.). Philadelphia; Society for Industrial and Applied Mathematics (1975).

From Conference on reliability and fault tree analysis; Berkeley, California, USA (3 Sep 1974).

See CONF-740906—.

In a phased mission the relevant system configuration (block diagram or fault tree) changes during consecutive time periods (phases). Many systems are required to perform phased missions. A classic example is a space vehicle. A reliability analysis for a phased mission encounters complexities not present with just one phase, but can be transformed into an analysis of a synthetic single phase case. The transformation has a potential for direct application, or can be used to study various computational algorithms and approximations.

4017 Testing for intervals of increased mortality. Birnbaum, Z.W. (Univ. of Washington, Seattle). pp 413-426 of In Reliability and fault tree analysis. Barlow, R.E. (ed.). Philadelphia; Society for Industrial and Applied Mathematics (1975).

From Conference on reliability and fault tree analysis; Berkeley, California, USA (3 Sep 1974).

See CONF-740906—.

To test the hypothesis of constant hazard rate against the alternative that there is a time interval in which that hazard rate is increased, a new statistic is proposed, in addition to some previously known statistics. A procedure is described and illustrated on examples, which utilizes computers and makes it possible to use these statistics in practice, although their sampling distributions are either not known or not numerically tabulated.

GEOSCIENCES

REFER ALSO TO CITATION(S) 3780

4018 Chemical and isotopic constraints on the origin of low-silica latite and andesite from the Andes of central Peru. Noble,

D.C. (Michigan Technological Univ., Houghton); Bowman, H.R.; Hebert, A.J.; Silberman, M.L.; Heropoulos, C.E.; Fabbi, B.P.; Hedge, C.E. *Geology;* 501-504(Sep 1975).

Low-silica latite highly enriched in large-ion-lithophile elements and moderately potassic low-Si andesite were erupted in central Peru during late Cenozoic time. FeO*/MgO ratios of 0.93 to 1.25 at 53 wt percent SiO_2 indicate a definitely calcalkalic character. The combination of low FeO*/MgO ratios, low SiO_2, and high Cr, Co, and Ni with large-ion-lithophile and light rare-earth elements makes it very unlikely that the parent magmas were produced by high-pressure partial melting of subducted ocean-floor basalt (eclogite). The data are more compatible with small degrees of partial melting of ultramafic material or mixtures of basalt and ultramafic mantle. The initial melts probably contained 52 to 53 percent SiO_2 and had a content of large-ion-lithophile elements nearly as high as that of the rocks. $^{87}Sr/^{86}Sr$ ratios of from 0.7042 to 0.7051 and low to very low Rb/Sr ratios indicate an isotopically variable source region that, at least in part, had earlier been depleted in Rb relative to Sr.

GEOLOGY AND HYDROLOGY

REFER ALSO TO CITATION(S) 2632

GEOPHYSICS

SEISMOLOGY AND TECTONICS

4019 Upper crustal low-velocity layers: possible effect of high temperature over a mantle upwarp at the basin range: Colorado Plateau transition. Smith, R.B. (Univ. of Utah, Salt Lake City); Braile, L.W.; Keller, G.R. *Earth Planet. Sci. Lett.;* **28**: No. 2, 197-204(Dec 1975).

Widespread observations of crustal reflections in conjunction with delayed refracted phases have been interpreted as evidence of upper crustal low-velocity layers. A plausible explanation of the low-velocity effect, determined from laboratory experiments on granites, suggests a decrease in the P-wave velocity of up to 0.2 km/sec in the depth range of 6 to 15 km that is produced by high temperatures. Synthetic seismograms computed for velocity-depth functions calculated from these temperature effects and corresponding to regional heat-flow provinces indicate three characteristics that define the upper crustal low-velocity layer: (1) high attenuation of Pg, (2) the presence of wide-angle, large-amplitude reflections (PcR), and (3) large PcR-Pg time differences. As an example of the possible effects of high heat flow (approximately 2.5 HFU), an upper crustal low-velocity layer is shown to correlate with a thin crust (25 km), a 9-km mantle upwarp, Pn velocities as low as 7.5 km/sec, an area of active seismicity, and a Cenozoic zone of normal faulting that all occur along the Basin Range—Colorado Plateau transition zone of the western United States.

MAGMATISM, VOLCANOLOGY, AND IGNEOUS PROCESSES

REFER ALSO TO CITATION(S) 2631

4020 Heat flow, radioactive heat generation, and theoretical tectonics for Northwestern Mexico. Smith, D.L. (Univ. of Florida, Gainesville). *Earth Planet. Sci. Lett.;* **23**: No. 1, 43-52(Aug 1974).

Nine heat flow values from Baja California and Sonora represent the first determinations of heat flux from Mexico and, in general, justify southerly extensions of the Basin and Range and Southern California thermal provinces of the southwestern United States. Heat flow in northern Baja California is low (0.84 hfu), consistent with known values from the Sierra Nevada Batholith, but a value of 1.23 hfu was recorded in the central area of the peninsula. Seven measurements from Sonora, averaging 2.5 hfu, are similar to Basin and Range values. Reduced heat flow values (q^*) have been calculated for Sonora and are interpreted as indicative of a separate Basin and Range thermal subprovince in Mexico. A tectonic model developed for northwestern Mexico attributes the high heat flow of the Basin and Range to behind arc extension associated with the termination of Cenozoic subduction. Opening of the Gulf of California and sea-floor spreading therein has provided a vent for the release of heat accumulated under northwestern Mexico. Thus, the southern portion of the Basin and Range province (in Mexico) appears to be cooling and narrowing and a subprovince of high reduced heat flow is defined east and perhaps southwest of the Gulf of California.

4021 Azores mantle blob: rare-earth evidence. Schilling, J.G. (Univ. of Rhode Island, Kingston). *Earth Planet. Sci. Lett.;* **25**: No. 2, 103-115(Mar 1975).

Rare earths (RE) in basalts erupted within the rift of the Mid-Atlantic Ridge show a progressive change from light-RE enriched to depleted patterns from the Azores Platform (40°N) down to 33°30′N. South, the pattern remains light-RE depleted as along other "normal ridge" segments. A progressive increase in chemical variability of the basalts towards the Azores is also noted. The latitudinal RE profile and corresponding $\Sigma FeO/\Sigma FeO + MgO$ variations, together, indicate that the origin of these basalts cannot be accounted for simply by considering variable extents of partial melting of a single mantle source and subsequent fractional crystallization during the ascent of the magmas. These two processes produce only second-order effects on the RE patterns. The data requires the presence of a distinct, light-RE richer, mantle source beneath the Azores Platform relative to that of south of 33°30′N and an intermediate zone where both mantle types mix. The relative contribution of the Azores mantle source to the mix appears to decrease fairly regularly southward along the ridge and becomes negligible at 33°30′N. Increasing chemical variability of the basalts towards the Azores is probably caused by correspondingly larger extent of fractional crystallization at shallow depth, and/or greater variability in the extent of partial melting, apparently subsequent to, and superimposed on the mixing of the two mantle sources. The combined morphological, geophysical and RE evidence along the profile are consistent with a model suggesting upwelling of a major blob (plume) under the Azores Plateau; and reveal the present extent of the blob's overflow and mixing with the asthenosphere depleted in large ionic lithophile trace elements. The influence of the Azores blob is geochemically detectable up to 1000 km southwestward beneath the ridge axis.

4022 Global heat flow: a new look. Chapman, D.S.; Pollack, H.N. (Univ. of Michigan, Ann Arbor). *Earth Planet. Sci. Lett.;* **28**: No. 1, 23-32(Nov 1975).

A global heat flow map has been derived from existing observations supplemented in areas without data by an empirical predictor based on tectonic setting and age. In continental areas the predictor is based on the observed correlation of heat flow with age of last tectono-thermal event, and in oceanic regions on the observed relation of heat flow to age of ocean floor. The predictor was used to assign mean heat flow values to 5° x 5° grid areas on the globe, weighted according to the relative area of tectonic provinces represented. A spherical harmonic analysis to degree 12 of the heat flow field yields a mean value of 59 mW m^{-2}, a rms residual of 13 mW m^{-2}, and an amplitude spectrum which decreases gradually and almost monotonically from $n = 1$. The spherical harmonic representation of the heat flow field is free of the unreal distortions which have characterized earlier analyses based on a geographically sparse data set. Areas with residuals greater than 15 mW m^{-2} comprise less than 19 percent of the area of the globe, thus indicating that most heat flow provinces have characteristic dimensions adequately represented in a 12-degree analysis.

4023 New terrestrial heat flow measurements on the Nazca Plate. Anderson, R.N. (Columbia Univ., Palisades, NY); Langseth, M.G.; Vacquier, V.; Francheteau, J. *Earth Planet. Sci. Lett.;* **29**: No. 2, 243-254(Mar 1976).

Sixty-seven new heat flow measurements on the Nazca Plate are reported, and the thermal regimes of three specific areas on the plate are examined. The Nazca Ridge is an aseismic ridge which may have been generated as an "island trail" from the Easter Island "hot spot" and/or may be a fossil transform fault. The Nazca Ridge has lower heat flow than the surrounding sea floor implying that the ridge might have low "effective" thermal conductivity causing heat to preferentially flow or refract to surrounding ocean crust which has higher conductivity, or, the low heat flow values may be caused by hydrothermal circulation on the ridge. The Carnegie Plateau is an elevated region south of the Carnegie Ridge on the northeastern Nazca Plate with high heat flow and shallow topography consistent with an age of less than 20 m.y. B.P. The central Nazca Plate is an area of highly variable heat flow which is possibly related to thin sediment and to rough regional topography.

4024 Heat flow in Lake Tahoe, California—Nevada, and the Sierra Nevada—Basin and Range transition. Henyey, T.L.; Lee, T.C. (Univ. of Southern California). *Geol. Soc. Am., Bull.;* **87**: No. 8, 1179-1187(Aug 1976).

Heat-flow measurements made in Lake Tahoe, California-Nevada, demonstrate that the transition from subnormal heat flow in the Sierra Nevada to above-normal heat flow in the Basin and Range province occurs west of the assumed physiographic boundary between these two areas, contrary to earlier belief. In addition, these data, together with data of other workers, clearly reveal the sharpness of this transition, which suggests that the causative thermal sources and (or) sinks must be restricted to depths not greater than the uppermost mantle. The way in which heat-flow data con-

strain the current hypotheses of crustal structure and evolution of the Sierra Nevada-Basin and Range provinces is illustrated with a tectonic model that employs a post-Cretaceous shallow-dipping subduction zone beneath the Sierra Nevada and an active upper-mantle diapir under the Basin and Range province during late Cenozoic time.

GEOPHYSICAL SURVEY METHODS

REFER ALSO TO CITATION(S) 2634

4025 Seismic transducer assembly for marshy terrains. Sutherland, B.C. (to to Walker-Hall-Sears, Inc.). US Patent 3,932,834. 13 Jan 1976. Filed date 23 Oct 1973. vp.

A seismic detector for marshy terrain consists of a pressure-sensitive transducer encapsulated in rubber which fills a rigid plastic cylindrical case. The case has several windows, to transmit the seismic wave pressure, and a conical end cap to facilitate planting into the ground.

4026 Method and apparatus for sensing when a seismic gas exploder is in contact with the Earth. Hearn, D.P. (to Atlantic Richfield Co.). US Patent 3,934,672. 27 Jan 1976. Filed date 25 Nov 1974. vp.

A two-position diaphragm actuated pressure switch monitors the fluid pressure generated by a hydraulic piston attached to a gas exploder seismic source as it falls back to earth to control the exploder firing circuit.

4027 Seismic explosive charge loader and anchor. McReynolds, O.B. US Patent 3,939,771. 24 Feb 1976. Filed date 3 Jun 1974. vp.

A seismic explosive charge loader has an upwardly facing cylindrical recess which loosely receives a wooden loading pole, and a downwardly facing cylindrical recess with tapered ribs and a circumferential groove to grip and hold available forms of explosive charge. The central body has transversely extending holes to receive wires that are bent up and out to anchor the loader in the borehole.

4028 Fluid-tight enclosure for geophone and cable. McNeel, W.O. (to Geo Space Corp.). US Patent Application B 492,902. 24 Feb 1976. Filed date 29 Jul 1974. vp.

Positive waterproof seals are formed by clamping a flexible header between a metal top plate and the metal housing of a geophone enclosure. The ends of the cable are fed into conical-shaped supports of the flexible header through holes in a nylon stress ring and knotted. The bottom of the stress ring is forced against an annular lip, which clamps the geophone in place and compresses an O-ring around the stud support. Thin electrical insulating material is placed between the geophone and the metal case.

4029 Line integral method of magnetoelectric exploration. Pirson, S.J. US Patent 3,943,436. 9 Mar 1976. Filed date 21 Jan 1974. vp.

It is claimed that electrotelluric currents are generated by deposits of oil, gas, and other minerals in the earth, and when closed line-integrals of the earth's magnetic field at the surface do not vanish, the residual values of such integrals give a measure of the magnitude and polarity of these electrotelluric current flux densities.

4030 Method and apparatus for seismic geophysical exploration. Weisten, D.H. (to Superior Oil Co.). US Patent 3,946,357. 23 Mar 1976. Filed date 23 Dec 1974. vp.

A control station generates a radio signal which synchronizes interval clocking systems in a seismic energy source and several remote geophone recording stations. Thereafter, the source and geophone recording stations operate at a specific time, or according to a preselected schedule, to acquire seismic data. The seismic data is sampled and digitized, stored in a memory device, summed with succeeding records, and ultimately put on magnetic tape.

4031 Synthetic display of seismic reflection strength. Anstey, N.A. (to Seiscom Delta Inc.). US Patent 3,946,356. 23 Mar 1976. Filed date 22 Feb 1974. vp.

A display is made, in cross-sectional form, of the theoretical strength of seismic reflections computed from calculated interval velocities and known or estimated densities. A comparison is then made with the amplitude of reflection signals shown on the seismic section in order to identify anomalous rock properties.

GEOCHEMISTRY

REFER ALSO TO CITATION(S) 2442

PHYSICS RESEARCH

ASTROPHYSICS AND COSMOLOGY

COSMIC RADIATION

REFER ALSO TO CITATION(S) 4085, 4098

STARS

REFER ALSO TO CITATION(S) 4173, 4257

4032 (ORO—3992-262) **Stellar energy loss rates due to SPT neutral currents.** Dicus, D.A.; Kolb, E.W. (Texas Univ., Austin (USA). Center for Particle Theory). May 1976. Contract E(40-1)-3992. 16p. Dep. NTIS $3.50.

The energy loss rate in stellar matter due to neutrino production is calculated assuming the weak leptonic neutral current includes scalar, pseudoscalar, or tensor covariants. The processes $e^+ + e^-$ yields $\nu +$ anti ν, $\gamma + e$ yields $\gamma + e + \nu +$ anti ν, $e + Z$ yields $e + Z + \nu +$ anti ν and $\gamma + \gamma$ yields $\nu +$ anti ν are considered in the respective temperature and density regions of physical significance. Comparison with observed stellar lifetimes allow an upper limit to be placed on the new couplings. (auth)

SOLAR PHENOMENA

REFER ALSO TO CITATION(S) 4128

4033 (LA-UR—76-494) **Solar-cosmic-ray variability.** Reedy, R.C. (Los Alamos Scientific Lab., N.Mex. (USA)). 1976. Contract W-7405-Eng-36. 7p. (CONF-760323—1). Dep. NTIS $3.50.

From 7. lunar science conference on utilization of lunar materials and expertise for large scale operations in space; Houston, Texas, United States of America (USA) (15 Mar 1976).

The maximum flux of particles from solar events that should be considered in designing the shielding for a space habitation is discussed. The activities of various radionuclides measured in the top few centimeters of lunar rocks are used to examine the variability of solar cosmic ray fluxes over the last five million years. 10 references. (auth)

4034 The energy flux of the sun. A critical discussion of standard values for the solar irradiance. Labs, D. (Heidelberg Univ. (F.R. Germany). Fachgruppe Astronomie). pp 1-19 of In Problems in stellar atmospheres and envelopes. Baschek, B.; Kegel, W.H.; Traving, G. (eds.) (Heidelberg Univ. (F.R. Germany). Lehrstuhl fuer Theoretische Astrophysik). Berlin, F.R. Germany; Springer (1975).

4 figs.; 3 tabs.; with refs.

The paper compares critically solar irradiance measurements carried out from groundbase and from high altitude aircraft platforms respectively. It tries to find out criteria - independent of the specific experiment - to decide which data have the higher probability to represent the radiation of the sun. A short review on the currently available measurements in the far ultraviolet is added.

COSMOLOGY

4035 (UCRL-Trans—11118) **Long gravitational waves in a closed universe.** Grishchuk, L.P.; Doroshkevich, A.G.; Yudin, V.M. (AN SSSR, Moscow. Inst. Prikladnoj Matematiki). 1975. Translation of USSR Preprint No. 87. 35p. Dep. NTIS $4.00.

The important part played by long gravitational waves in the evolution of a homogeneous closed universe (model of type IX in Biancki's classification) is discussed. It is shown that the metric of this model can be represented in the form of a sum of a background metric, describing nonstationary space of constant positive curvature, and a group of terms that may be interpreted as a set of gravitational waves of maximal length compatible with closure of the space. This subdivision of the metric is exact and does not presuppose necessary smallness of the wave corrections. For this reason the behavior of the wave terms can be traced at all stages of their evolution—both in the epoch when the contribution of the "energy density" and "pressure" of the gravitational waves to the dynamics of the background universe is negligibly small and

in the epoch when this contribution is dominant. It was demonstrated, in particular, that in the limiting case of complete absence of ordinary matter the scale factor of the background metric, because of the negativity of gravitational "pressure," can pass during the evolution of the universe through a state of stable regular minimum.

PLANETARY PHENOMENA

REFER ALSO TO CITATION(S) 4033

4036 (LA-UR—76-972) **Surface chemistry of selected lunar regions.** Bielefeld, M.J.; Reedy, R.C.; Metzger, A.E.; Trombka, J.I.; Arnold, J.R. (Los Alamos Scientific Lab., N.Mex. (USA)). 1976. Contract W-7405-Eng-36. 31p. (CONF-760323—4). Dep. NTIS $4.00.

From 7. lunar science conference on utilization of lunar materials and expertise for large scale operations in space; Houston, Texas, United States of America (USA) (15 Mar 1976).

A completely new analysis has been carried out on the data from the Apollo 15 and 16 γ ray spectrometer experiments. The components of the continuum background have been estimated. The elements Th, K, Fe and Mg give useful results; results for Ti are significant only for a few high Ti regions. Errors are given, and the results are checked by other methods. Concentrations are reported for about sixty lunar regions; the ground track has been subdivided in various ways. The borders of the maria seem well-defined chemically, while the distribution of KREEP is broad. This wide distribution requires emplacement of KREEP before the era of mare formation. Its high concentration in western mare soils seems to require major vertical mixing. (auth)

4037 (UCRL—77658) **Mascon ages and sinking rates.** Heard, H.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 16 Apr 1976. Contract W-7405-Eng-48. 19p. (CONF-760323—2). Dep. NTIS $3.50.

From 7. lunar science conference on utilization of lunar materials and expertise for large scale operations in space; Houston, Texas, United States of America (USA) (15 Mar 1976).

The long-term mechanical stability of strongly positive gravity anomalies (mascons) on the moon is evaluated from relevant physical characteristics of these bodies, from paleoselenotherms, and from the flow behavior of the lunar mantle. (auth)

ATOMIC, MOLECULAR, AND CHEMICAL PHYSICS

BEAMS AND THEIR REACTIONS

REFER ALSO TO CITATION(S) 4039

4038 **Electron spectroscopic studies of semiconductor surfaces.** Ibach, H. (Kernforschungsanlage, Juelich, Ger.). pp 655-664 of In Physics of semiconductors. Pilkuhn, M.H. (ed.). Stuttgart; B. G. Teubner (1974).

From 12. international conference on the physics of semiconductors; Stuttgart, F.R. Germany (15 Jul 1974).

See CONF-740722—.

The density and excitation spectrum of electronic surface states may be investigated by ultraviolet photoemission and electron energy loss spectroscopy. Results are presented for clean silicon surfaces of different orientation and surface structure. In addition to the dangling bond surface states deep lying surface states associated with the backbonds of the silicon surface atoms have been found. (auth)

ATOMIC AND MOLECULAR PROPERTIES

REFER ALSO TO CITATION(S) 4046

4039 **High resolution laser spectroscopy of the D-lines of on-line produced radioactive sodium isotopes.** Duong, H.T. (CNRS, Orsay, France); Jacquinot, P.; Juncar, P.; Liberman, S.; Pinard, J.; Vialle, J.L.; Huber, G.; Klapisch, R.; Thibault, C. pp 145-149 of In Laser spectroscopy. Haroche, S.; Pebay-Peyroula, J.C.; Haensch, T.W.; Harris, S.E. (eds.). New York; Springer-Verlag (1975).

From Conference on laser spectroscopy; Megeve, France (23 Jun 1975).

See CONF-7506103—.

The hyperfine sublevels of the ground states of sodium isotopes, mass numbers 20—25, were excited by optical pumping with a tuneable single-mode dye laser. A summary of the numerical results for the isotope shifts is given. 6 figs, 1 table, 6 refs. (GHT)

4040 **Ir spectrum of curium-244.** Conway, J.G. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.); Blaise, J.; Verges, J. *Spectrochim. Acta, Part B;* **31B**: No. 1, 31-47(7 Feb 1976).

The spectrum of curium-244 has been observed on the high resolution Fourier-transform spectrometer at Laboratoire Aime Cotton. An eletrodeless lamp containing 50 μg of CmI_3 was run for 12 hr and 800,000 points were taken. A total of 1743 lines have been ascribed to curium and 87% of the lines have been assigned to transitions between known energy levels.

POSITRONIUM, MUONIUM, AND MUONIC AND MESIC ATOMS AND MOLECULES

4041 **2P/sub 3/2/—2S/sub 1/2/ energy difference in very light muonic systems.** Zavattini, E. (CERN, Geneva). pp 370-379 of In Laser spectroscopy. Haroche, S.; Pebay-Peyroula, J.C.; Haensch, T.W.; Harris, S.E. (eds.). New York; Springer-Verlag (1975).

From Conference on laser spectroscopy; Megeve, France (23 Jun 1975).

See CONF-7506103—.

Experiments to detect the 2P/sub $^3/_2$/—2S/sub $^1/_2$/ transition in muonic atoms of hydrogen, helium and deuterium are described. Using the CERN muon channel of the 600 MeV synchro-cyclotron and appropriate targets, muonic atoms in the 2S state (metastable) are irradiated with laser light tuned to induce the transition. The "resonance" wavelength needed to induce the transition is thus determined. Results are presented. (GHT)

4042 **Experimental study of nuclear excitation with neutron emission, induced by cascading muons in ^{197}Au, ^{206}Pb, ^{207}Pb, ^{208}Pb, ^{209}Bi, and natural Tl.** Ricci, A.M.V. Ottawa; Carleton Univ. (1975). vp.

Thesis (Ph. D.).

An experimental investigation of the prompt nuclear emission of neutrons induced by a cascading negative muon after atomic capture in ^{197}Au, ^{206}Pb, ^{207}Pb, ^{208}Pb, ^{209}Bi and natural Tl is presented. The energy spectra and the intensities have been compared with the theoretical predictions available to date and are in substantial agreement with the results of the model used by Srinivasan and Sundaresan.

4043 **Observation of dynamic E2 mixing via kaonic X-ray intensities.** Godfrey, G.L.; Lum, G.K.; Wiegand, C.E. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). *Phys. Lett., B;* **61**: No. 1, 45-46(1 Mar 1976).

A nuclear resonance effect has been observed between a kaonic atom and a nuclear transition in ^{98}Mo. The measurement gave ^{98}Mo(n=6yields5)/^{98}Mo(n=6yields5)=0.16+-0.16 instead of the no-mixing value of 1. Dynamic E2 mixing caused kaons to be strongly absorbed from the ^{98}Mo atomic state n=6, l=5 in agreement with theoretical predictions.

COLLISION PHENOMENA

4044 (ANL—76-80) **Theory of ionization by electron collisions.** Fano, U. (Argonne National Lab., Ill. (USA)). Jun 1976. Contract W-31-109-Eng-38. 47p. Dep. NTIS $4.50.

The problem of calculating comprehensive sets of cross sections for ionization of atoms and molecules is reviewed. Emphasis is put on targets that are already ionized and lower-energy collisions for which the incident electron must be treated on a par with target electrons. The physical circumstances are discussed in which perturbation methods should be adequate, and special investigations are recommended to identify the relevant ranges of parameters more precisely and dependably. A new R-matrix approach is outlined which should permit rather simple, approximate, but dependable calculations when the perturbation methods fail.

4045 (COO—3247-34) **Generalized oscillator strengths. Technical progress report, six years, January 1, 1970—July 1, 1976.** Lassettre, E.N. (Carnegie-Mellon Univ., Pittsburgh, Pa. (USA)). 1976. Contract E(11-1)-3247. 74p. Dep. NTIS $4.50.

Progress in the study of generalized oscillator strengths since January 1, 1970 is reviewed. The status of methods for the experimental determination of electron collision cross sections and generalized oscillator strengths is discussed including the comparison of inelastic and elastic scattering when elastic cross sections are available, the use of a comparison gas with a transition of known cross section, and the determination of optical oscillator strengths from forward scattering spectra. Outstanding discrepancies between limiting generalized oscillator strengths (at zero momentum change) and optical oscillator strengths are resolved for the most part. There are no longer any outstanding discrepancies

involving refractive indices. Two new selection rules, one relating to singletesinglet transitions, the other to singlet-triplet transitions are described. Other deviations from the Born approximation at large momentum changes are discussed. Generalized oscillator strengths are applied to the calculation of cross sections (in Born approximation) for resonant energy transfer in collision between two molecules one of which is excited. A list of publications is included.

4046 (LA-UR—76-1315) **Recent measurements concerning uranium hexafluoride-electron collision processes.** Trajmar, S.; Chutjian, A.; Srivastava, S.; Williams, W.; Cartwright, D.C. (Los Alamos Scientific Lab., N.Mex. (USA)). 1976. Contract W-7405-Eng-36. 8p. (CONF-760646—2). Dep. NTIS $3.50.

From Symposium on uranium plasmas; Princeton, New Jersey, United States of America (USA) (10 Jun 1976).

Scattering of electrons by UF_6 molecule was studied at impact energies ranging from 5 to 100 eV and momentum transfer, elastic and inelastic scattering cross sections were determined. The measurements also yielded spectroscopic information which made possible to extend the optical absorption cross sections from 2000 to 435A. It was found that UF_6 is a very strong absorber in the vacuum UV region. No transitions were found to lie below the onset of the optically detected 3.0 eV feature.

4047 (LBL—5114) **Potential energy surfaces for ion-molecule reactions. Intersection of the $^3A_2$ and $^3B_1$ surfaces of NH^+_2.** Bender, C.F.; Meadows, J.H.; Schaefer, H.F. III. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Apr 1976. Contract W-7405-ENG-48. 23p. (CONF-760901—2). Dep. NTIS $3.50.

From Faraday discussion on potential energy surfaces; Brighton, United Kingdom of Great Britain and Northern Ireland (UK) (8 Sep 1976).

A theoretical study of two of the low-lying NH_2^+ potential energy surfaces was performed. The intersection and avoided intersection (for C/sub s/ geometries) of the lowest $^3A_2$ and $^3B_1$ surfaces allows a pathway by which the ground state of HH_2^+ may be accessed without a potential barrier. The electronic structure calculations employed a double zeta plus polarization basis set, and correlation effects were taken into account using the newly developed Vector Method (VM). To test the validity of this basis, additional self-consistent-field studies were performed using a very large contracted gaussian basis N(13s 8p 3d/9s 6p 3d), H(6s 2p/4s 2p). The $^3A_2$ surface, on which N^+ and H_2 may approach, has a surprising deep potential minimum, approximately 60 kcal/mole, occurring at r/sub e/(NH) approximately 1.26 A and theta/sub e/(HNH) approximately 43°. Electron correlation is responsible for about 15 kcal of this well depth, which appears fairly insensitive to extension of the basis set beyond the double zeta plus polarization level. The line of intersection (or seam) of the $^3A_2$ and $^3B_1$ surfaces is presented both numerically and pictorially. The minimum energy along this seam occurs at approximately 51 kcal below separated $N^+ + H_2$. Thus for sufficiently low energies one expects $N^+ - H_2$ collisions to provide considerable "complex formation." 3 figs, 1 table, 28 refs.

4048 (ORNL—5137, pp 92-105) **Experimental atomic physics.** Sellin, I.A.; Elston, S.B.; Forester, J.P.; Liao, K.H.; Pegg, D.J.; Peterson, R.S.; Thoe, R.S.; Hayden, H.C.; Griffin, P.M. May 1976.

In Physics Division annual progress report for period ending December 31, 1975.

The atomic structure and collision phenomena of highly stripped ions in the range Z = 6 to 35 were studied. Charge-transfer and multiple-electron-loss cross sections were determined. Absolute x-ray-production cross sections for incident heavy ions were measured. 10 figures, 1 table. (RWR)

4049 (ORO—(40-1)-5002-4) **Theoretical investigation and calculation of certain atomic and molecular processes important in the formation and destruction of excited stable gas molecules (or excimers). Technical progress report, October 1, 1975—September 1, 1976.** Flannery, M.R. (Georgia Inst. of Tech., Atlanta (USA). School of Physics). 1976. Contract E-(40-1)-5002. 110p. Dep. NTIS $5.50.

A full theoretical treatment is developed for the determination of the rates of three body ion-atom conversion and coded for computers. Various approximations are also proposed. The cross sections for photoionization of molecular hydrogen in various vibrational levels v/sub i/ of the ground electronic state have been calculated as a function of photon frequency ν, and of the initial and final vibrational levels v/sub i/ and v/sub f/ of H_2 and H_2^+ respectively. Excellent agreement with measurements of the photoionization of H_2(v/sub i/ = 0) was obtained. In addition, a major review of the three-body ionic recombination was performed. Calculations of cross sections for molecular charge transfer reactions involving tritium were also carried out.

ATOMIC AND MOLECULAR THEORY

4050 (ORO—2408-113) **Inner-shell physics after fifty years of quantum mechanics.** Merzbacher, E. (North Carolina Univ., Chapel Hill (USA). Dept. of Physics and Astronomy). 1976. Contract E(40-1)-2408. 13p. (CONF-760326—2). Dep. NTIS $3.50.

From 2. international conference on inner-shell ionization phenomena; Freiberg, German, Federal Republic of (F.R. Germany) (29 Mar 1976).

A historical view is given of how the development of quantum mechanics has been affected by the information relating to inner shells, gathered by physicists since the early days of atomic physics, and of the impact of quantum mechanics on the physics of inner atomic shells. 25 refs. (GHT)

FLUID PHYSICS

REFER ALSO TO CITATION(S) 3552

GENERAL FLUID DYNAMICS

REFER ALSO TO CITATION(S) 4344

4051 (COO—2126—36) **Technical progress report, September 1, 1975—August 31, 1976.** (Chicago Univ., Ill. (USA)). 1976. Contract E(11-1)-2126. 6p. Dep. NTIS $3.50.

The electronic and vibrational excitations of disordered, partially ordered, and ordered solids, as well as related liquids and gases, were studied using Raman, Brillouin, and infrared spectroscopy, together with extrinsic perturbations such as temperature and uniaxial stress.

4052 (UCRL-Trans—11120) **Application of spherical functions in gas-dynamic problems.** Podlivaev, I.F. (AN SSSR, Moscow. Inst. Prikladnoj Matematiki). 1975. Translation of USSR Preprint No. 91. 20p. Dep. NTIS $3.50.

Expansions of the solutions of three-dimensional gas-dynamic problems are given in Euler variables in generalized spherical functions. Equations were constructed for coefficients of the expansion, having the form of a system with two variables: time and radius.

PROPERTIES AND STRUCTURE OF FLUIDS

4053 (UCRL-Trans—11121) **Spectra Orr-Sommerfeld problem.** Babenko, K.I.; Stebunov, V.A. (AN SSSR, Moscow. Inst. Prikladnoj Matematiki). 1975. Translation of USSR Preprint No. 93. 31p. Dep. NTIS $4.00.

A numerical algorithm is considered for the solution of the spectral Orr—Sommerfeld problem about the stability of flows of a viscous incompressible liquid in a plane channel, reducing this problem to an algebraic problem of eigenvalues. The proposed algorithm has a high accuracy and makes it possible to obtain a large number of eigenvalues. Results of numerical calculations are given for flows with various velocity profiles.

SUPERFLUIDITY

4054 **Acoustic modes of superfluid helium in a waveguide partially packed with superleak.** Heiserman, J.; Rudnick, I. (Univ. of California, Los Angeles). *J. Low Temp. Phys.*; **22**: No. 5/6, 481-499(Mar 1976).

The velocities of the two acoustic modes of superfluid helium contained in an annular waveguide packed to a fraction of its depth with superleak material have been measured. The depth of the superleak was varied and the dependence of the velocities on the depth was determined. The results are compared with theory and good agreement is found. Explanations for some observed departures are discussed.

4055 **Thermodynamic properties of ^{4}He. II. The bcc phase and the P—T and V—T phase diagrams below 2K.** Hoffer, J.K.; Gardner, W.R.; Waterfield, C.G.; Phillips, N.E. (Univ. of California, Berkeley). *J. Low Temp. Phys.*; **23**: No. 1/2, 63-102(Apr 1976).

The constant-volume heat capacity of ^{4}He has been measured at molar volumes from 20.45 to 29.71 cm^3/mole in the temperature range from 0.3 to 4 K. The entropy has been obtained as a function of volume and temperature by extrapolation of the data to 0 K. The P—T equilibrium curves below 2 K were obtained

from the volume dependence of the entropy in the two-phase regions. The V—T curves were obtained above 1.25 K by observation of heat capacity discontinuities at the phase boundaries and below 1.25 K from the equilibrium pressure-temperature data and the properties of pure phases. The minimum in the melting pressure occurs at 0.774 K and is 8.04 x 10^{-3} atm below the 0 K value. The corresponding maxima in the molar volumes of the solid and liquid were also determined. Both the temperature and volume dependence of the heat capacity are similar to those of bcc ^{3}He, in the very limited ranges of volume and temperature in which the phase could be studied. An unexpected rise in heat capacity in the 20 mK interval below the melting temerature was observed.

4056 Exact results for transport properties of anisotropic Fermi superfluids near the transition temperature. Pethick, C.J. (Univ. of Illinois, Urbana); Smith, H.; Bhattacharyya, P. *J. Low Temp. Phys.*; **23**: No. 1/2, 225-230(Apr 1976).

Transport and relaxation processes in an anisotropic superfluid close to the transition temperature are discussed by deriving the quasiparticle Boltzmann equation. As an application the shear viscosity of liquid ^{3}He is calculated exactly to first order in the superfluid gap, in terms of normal state properties. Exact results for the transport coefficients and relaxation rates in the superfluid enable one to extract precise information about normal state scattering amplitudes from measurements in the superfluid phases.

4057 Hydrodynamic shifts in the NMR of superfluid ^{3}He. Fetter, A.L. (Stanford, Univ., CA). *J. Low Temp. Phys.*; **23**: No. 3/4, 245-265(May 1976).

A Ginzburg—Landau expansion is used to derive the effect of uniform hydrodynamic flow on the equilibrium configuration of B-^{3}He and A-^{3}He. Leggett's theory determines the corresponding dynamic magnetic phenomena. Increasing flow velocity shifts both the cw resonance frequencies and the ringing signal after a sudden increment in the static magnetic field.

4058 Magnetic excitations in superfluid ^{3}He. Maki, K.; Ebisawa, H. (Univ. of Southern California, Los Angeles). *J. Low Temp. Phys.*; **23**: No. 3/4, 351-365(May 1976).

Localized magnetic excitations (solitons) in superfluid ^{3}He are studied theoretically. In the A phase, a calculation is made of the dispersion of solitons in both the longitudinal and the transversal configurations, in the B phase we limit ourselves to the longitudinal soliton in the Leggett configuration. In the wall pinned configuration of the B phase we show that the magnetic perturbation propagates as spin wave. The effects of the spin-diffusion term on solitons as well as spin waves are considered. The soliton velocity decreases exponentially in time owing to the spin-diffusion term with a characteristic time GAMMA^{-1}[identical with $(3)(c^2/D\Omega^2)$], where D is the spin-diffusion constant, Ω is the Leggett frequency, and c is the spin-wave velocity.

4059 From kinetic theory to hydrodynamics: uniform anisotropic superfluids. Saslow, W.M. (Cornell Univ., Ithaca, NY). *J. Low Temp. Phys.*; **23**: No. 3/4, 495-505(May 1976).

Starting from kinetic theory, and neglecting dissipation, the hydrodynamic equations for anisotropic superfluids are derived. Only the case of a uniform texture in the absence of finite external fields is considered. Other than possessing a normal fluid density which is a diagonal tensor, anisotropic superfluids are characterized by the same hydrodynamics as in the isotropic case. These results constitute a generalization of the kinetic theory of Khalatnikov, which applies to the case of an isotropic quasiparticle spectrum dependent only on density.

4060 Possible superfluidity of ^{6}He: its phase diagram and those of ^{6}He—^{4}He and ^{6}He—^{3}He mixtures. Nosanow, L.H. (National Science Foundation, Washington, DC). *J. Low Temp. Phys.*; **23**: No. 5/6, 605-621(Jun 1976).

The properties of pure ^{6}He and ^{6}He—^{4}He and ^{6}He—^{3}He mixtures are studied within the context of the quantum theorem of corresponding states. For pure ^{6}He, it is found that there is a small, but definite, region where it is expected to be superfluid. For the ^{6}He—^{4}He mixture, it is found that there is a "lambda-eutectic" temperature, approximately 1.2 K, below which it is expected that both ^{6}He and ^{4}He will be part of the superfluid at all concentrations. Experiments to observe ^{6}He superfluidity are discussed, and it is concluded that such experiments are feasible, although they may be quite difficult to carry out. Experiments are discussed to use a ^{6}He generator (should it be possible to construct it) as a probe to study various properties of liquid and solid helium.

4061 Zero-sound studies in superfluid ^{3}He. Paulson, D.N.; Kleinberg, R.L.; Wheatley, J.C. (Univ. of California, San Diego, La Jolla). *J. Low Temp. Phys.*; **23**: No. 5/6, 725-741(Jun 1976).

The propagation of 5-, 15-, and 25-MHz sound in superfluid ^{3}He has been studied in zero magnetic field over a wide pressure range. Measurements of the structure and location of the attenuation peaks, velocity changes, and the low-temperature attenuation are described. The degree of strong coupling in the B phase is discussed. Observations of superheating and supercooling near the polycritical point have been extended and comparison is made with theory.

4062 Dielectric constant and molar volume of saturated liquid ^{3}He and ^{4}He. Kierstead, H.A. (Argonne National Lab., IL). *J. Low Temp. Phys.*; **23**: No. 5/6, 791-805(Jun 1976).

Measurements are reported of the dielectric constant of ^{3}He in the temperature range from 0.5 to 2.4 K and of ^{4}He from 0.7 to 4.2 K. From these measurements the molar volumes of the two isotopes have been calculated for the same temperature ranges, using the polarizabilities reported by Kerr and Sherman.

OTHER QUANTUM FLUIDS

4063 Extraction of charged droplets from charged surfaces of liquid dielectrics. Boyle, F.P.; Dahm, A.J. (Case Western Reserve Univ., Cleveland). *J. Low Temp. Phys.*; **23**: No. 3/4, 477-486(May 1976).

Charges are extracted from charged liquid-vapor interfaces in a diode semi-immersed in liquid helium or nitrogen at moderate applied electric fields. A sudden onset of positive charge in the case of helium and of either sign in the case of nitrogen is collected in the vapor at a critical field given smpirically by E/sub c/ = (12.3 +- 0.8) (Δ rho sigma)$^{0.25+-0.03}$ kV/cm, where Δ rho is the difference between the liquid and gas densities, and sigma is the surface tension. The data are explained by a model in which charged droplets are extracted from the liquid state with a radius of r/sub c/ = (3 sigma/Δ rho g)/sup $^1/_3$/, where g is the acceleration of gravity. The current noise is peaked at low frequencies, which possibly indicates a correlation between droplets due to surface waves. If charge is prevented from leaking off the surface by appropriate electrodes, the increased surface charge macroscopically lifts the surface before entering the vapor and generates surface waves in one of the modes of the cylindrical cell.

PARTICLE INTERACTIONS AND PROPERTIES - EXPERIMENTAL

REFER ALSO TO CITATION(S) 4102, 4123

4064 (COO—2232A-32) **Experimental studies of elementary particle interactions at high energies. Technical progress report.** (Rockefeller Univ., New York (USA)). Jan 1976. Contract E(11-1)-2232. 22p. Dep. NTIS $3.50.

Experimental research in high energy physics is summarized. A list of publications is included. (JFP)

4065 (ORNL—5137, pp 153-155) **High-energy and medium-energy activities.** Cohn, H.O.; Condo. G.T.; Bugg, W.M.; Hart, E.L.; Brashear, H.R.; Handler, T.H. May 1976.

In Physics Division annual progress report for period ending December 31, 1975.

Activities of the High-Energy Program at ORNL included participation in a π^-p experiment with 150-GeV/c pions at the Fermi National Accelerator Laboratory. The experiment was done with a hybrid system employing the 76.2-cm bubble chamber and wire proportional counters. New data were obtained with the same setup for positive-pion interactions at the same momentum. Further effort was put into the study of low-energy physics with high-energy techniques by further analyzing data obtained at BNL of interaction of anti p and K^- in plates inserted in a 76.2-cm bubble chamber. Measurement of interaction of pions in the 208.3-cm SLAC bubble chamber has continued, leading to completion of the measurement phase of a π^+—deuterium interaction experiment and accumulation of data for a π^-—proton experiment. 1 figure, 1 table. (RWR)

4066 (ORO—2504-247) **High Energy Accelerator and Colliding Beam User Group. Progress report, 1976—1977.** (Maryland Univ., College Park (USA). Dept. of Physics and Astronomy). Jul 1976. Contract ET(40-1)-2504. 62p. Dep. NTIS $4.50.

Research on experimental high energy physics is summarized. A list of publications is included. (JFP)

4067 Particle searches and discoveries, 1976. Conference held at Nashville, Tennessee, 1—3 March 1976. Panvini, R.S. (ed.). New York; American Institute of Physics (1976). 348p. (CONF-760344—).

From Conference on particle searches and discoveries; Nashville, Tennessee, United States of America (USA) (1 Mar 1976).

Separate abstracts were prepared for the 29 papers presented. (JFP)

4068 Results from DORIS, DASP. Pretzl, K.P. (Max Planck Institut fuer Physik und Astrophysik, Munich). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 30, 248-273(1976).

From Conference on particle searches and discoveries; Nashville, Tennessee, United States of America (USA) (1 Mar 1976).

See CONF-760344—.

An updated report is given on the results of the DASP-Collaboration obtained at the e^+e^- storage rings DORIS at DESY (Hamburg) on inclusive distributions, particle ratios, mass searches in J/psi and psi' decays, hadronic two body decays of J/psi and psi', radiative decays of J/psi and psi'.

ELECTROMAGNETIC INTERACTIONS

REFER ALSO TO CITATION(S) 4106

4069 Production of high mass e^+e^- pairs at Fermilab. Appel, J.A. *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 30, 1-12(1976).

From Conference on particle searches and discoveries; Nashville, Tennessee, United States of America (USA) (1 Mar 1976).

See CONF-760344—.

Electron-positron pairs with an effective mass up to 10 GeV were observed in proton-beryllium collisions at 400 GeV at Fermilab. In addition to high mass continuum events, evidence is presented for a new resonance at 6 GeV. The J/psi is observed and its production dynamics measured near x of 0 and out to P/sub T/ of 1.6 GeV. The decay angular distribution is found to be best fit with $(1 + \cos^2\theta^*)$. A 90 percent C.L. upper limit of 2 percent is placed on the branching ratio times cross section for psi' relative to psi.

4070 psi and excess leptons in photoproduction. Ritson, D.M. (Stanford Univ., CA). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 30, 75-82(1976).

From Conference on particle searches and discoveries; Nashville, Tennessee, United States of America (USA) (1 Mar 1976).

See CONF-760344—.

The A-dependence of psi photoproduction was measured on beryllium and tantalum. From this are found sigma/sub psi N/ = 2.75 +- 0.90 mb. A study was made of excess leptons relative to pion production in photoproduction. A μ/π ratio of 1.40 +- 0.25 x 10^{-4} was found at 20 GeV incident photon energy. The energy dependence of psi photoproduction was determined and appeared to have a "pseudo-threshold" at 12 GeV.

4071 Review of CERN—Columbia—Rockefeller—Saclay experiment. Segler, S.L. (Rockefeller Univ., New York). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 30, 123-133(1976).

From Conference on particle searches and discoveries; Nashville, Tennessee, United States of America (USA) (1 Mar 1976).

See CONF-760344—.

The results on direct electron production in p—p collisions at the CERN ISR from the CCRS collaboration are reviewed. In particular, the cross sections are presented at $\sqrt{s}$ = 22.5, 30.6, 44.8, 52.5 and 62 GeV and compared with the π^0 cross section. Correlations with hadrons are given and compared with those for pions. Finally, a comparison is made with the contribution to single e's from the J/psi and with upper limits obtained for low mass e^+e^- pairs, i.e., .3 less than or equal to M/sub ee/ less than or equal to .8 GeV/c^2.

4072 Production of direct positrons at 256 and 800 MeV. Mischke, R.E. (Los Alamos Scientific Lab., NM). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 30, 134-141(1976).

From Conference on particle searches and discoveries; Nashville, Tennessee, United States of America (USA) (1 Mar 1976).

See CONF-760344—.

Results are presented for direct positron production in p—p collisions below 1 GeV. The invariant cross sections are $E(d^3\sigma/dp^{cb}) = (3.8 \pm 5.4) \times 10^{-32}$ and $(-8 \pm 12) \times 10^{-32}$ cm^3/[sr . (GeV/c)^3] at 256 and 800 MeV, respectively. These results are consistent with zero and indicate the threshold for direct lepton production is at an energy above 1 GeV.

4073 Inclusive particle production and anomalous muons in e^+e^- collisions at SPEAR. Barnett, B.A. (Univ. of Maryland, College Park). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 30, 285-303(1976).

From Conference on particle searches and discoveries; Nashville, Tennessee, United States of America (USA) (1 Mar 1976).

See CONF-760344—.

Results are presented on hadron and muon inclusive production in e^+e^- collisions at $\sqrt{s}$ = 3.8 and 4.8 GeV. Anomalously large high momentum muon production is observed in noncoplanar two charged particle final states, but no anomalies are seen in multicharged particle final states. Arguments are presented that these extra muons do not come from charmed particles but could possibly come from heavy leptons. Results are also presented on a search for e^+e^- narrow resonances with 5.7 GeV less than M/sub ee/ less than 6.1 GeV. The T/sub (5.97)/ was not seen in this scan which means that GAMMA/sub ee/ is less than 100 eV if the T has decay modes similar to the psi and psi'.

4074 Other structure in e^+e^- annihilation. Breidenbach, M. (Stanford Linear Accelerator Center, CA). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 30, 305-319(1976).

From Conference on particle searches and discoveries; Nashville, Tennessee, United States of America (USA) (1 Mar 1976).

See CONF-760344—.

The total cross section for the production of hadrons in e^+e^- annihilation exhibits complex structure in the region of center-of-mass energy about 4 GeV, where R, the ratio of the hadron to μ-pair cross sections, changes from a plateau value of about 2.5 to a new flat region of about 5.2. Corresponding structure is not seen in exclusive $2(\pi^+\pi^-)$ and $3(\pi^+\pi^-)$ cross sections, nor is structure seen in identified K^- spectra. Anomalous e-μ events are observed above an E/sub c.m./ of about 4 GeV, which are not explainable as arising solely from K^0 semileptonic decays of charmed mesons, or from two body decays of a new meson.

WEAK INTERACTIONS

REFER ALSO TO CITATION(S) 4090, 4099

4075 (COO—1428-436) Evidence for a neutrino-induced dilepton event in the A.N.L. 12-foot bubble chamber. Garfinkel, A.F. (Purdue Univ., Lafayette, Ind. (USA)). 1976. Contract E(11-1)-1428. 14p. Dep. NTIS $3.50.

The event νp(n/sub s/) yields $\mu^- p\pi^+\pi^-\pi^0 e^+$ ν/sub e/(n /sub s/), found in a bubble chamber, is considered. It is concluded that this event is clearly unusual when explained in terms of normal neutrino interactions. But if it is an example of dilepton production, it occurs at the expected rate of single lepton production. If it is due to the weak decay of a new baryon, the baryon mass appears to be near 2 GeV/c^2 and is unlikely to be as high as 2.4 GeV/c^2. (JFP)

4076 Search for new particles in proton—nucleus collisions at 400 GeV/c. Bintinger, D. (Fermi National Accelerator Lab., Batavia, IL); Jovanovic, D.; Lundy, R.; Akerlof, C.; Alley, P.; Koltick, D.; Loveless, R.; Ditzler, R.; Finley, D.; Loeffler, F. *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 30, 30-37(1976).

From Conference on particle searches and discoveries; Nashville, Tennessee, United States of America (USA) (1 Mar 1976).

See CONF-760344—.

Preliminary results from a search for new particles produced in proton-nucleus collisions at 400 GeV/c are reported. A double-arm spectrometer is used to detect two-body final states where each spectrometer arm has the capability of uniquely identifying π/sup +-/, K/sup +-/, p, anti p, μ/sup +-/, and phi. The J/psi is measured in the $\mu^+\mu^-$ mode.

4077 Comments on session concerning new-particle searches. Ferbel, T. (Univ. of Rochester, NY). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 30, 107-108(1976).

From Conference on particle searches and discoveries; Nashville, Tennessee, United States of America (USA) (1 Mar 1976).

See CONF-760344—.

The properties of the J/psi particle and searches for charm-like objects in hadronic collisions are summarized. It is concluded that better experiments are needed to find charm in hadronic channels. One way to enhance one's chances of finding charm is to capitalize on the fact that charmed particles must have leptonic or semileptonic decay modes. (JFP)

4078 Direct production of muons in the forward direction by 300-GeV protons on uranium. Johnson, R.; Buchholz, D.; Fackler, O.; Frisch, H.J.; Segler, S.L.; Shochet, M.J.; Sumner, R.L. *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 30, 116-122(1976).

From Conference on particle searches and discoveries; Nashville, Tennessee, United States of America (USA) (1 Mar 1976).

See CONF-760344—.

An experiment is described having for its purpose the answer to the question of whether the μ/π ratio, measured to be about 10^{-4}, is compatible with the idea that the muons are decay products of massive mesons. Proton reactions with uranium were used as a production means. (JFP)

4079 7 ft bubble chamber ν experiment at Brookhaven National Laboratory. Cnops, A.M.; Connolly, P.L.; Louttit, R.I.; Murtagh, M.J.; Palmer, R.B.; Samios, N.P.; Tso, T.T.; Williams, H.H. (Brookhaven National Lab., Upton, NY). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 30, 162-172(1976).

From Conference on particle searches and discoveries; Nashville, Tennessee, United States of America (USA) (1 Mar 1976).

See CONF-760344—.

Preliminary results on the 7′ bubble chamber ν experiment concerning exposures in H_2 and D_2, with a yield of 850 ν interactions are presented; in particular 10 charged current strange particle events are analyzed, that provide a cross section ratio to nonstrange particle interactions of .04 +- .02 at our energies.

4080 Observation of the reaction νp yields νp. Pang, C.Y. (Univ. of Illinois, Urbana). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 30, 173-179(1976).

From Conference on particle searches and discoveries; Nashville, Tennessee, United States of America (USA) (1 Mar 1976).

See CONF-760344—.

The reaction νp yields νp was observed in an experiment conducted at the Brookhaven AGS. Experimental details and a comparison with quasi-elastic neutrino scattering are presented.

4081 Neutral current couplings. Barish, B.C. (California Inst. of Tech., Pasadena). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 30, 180-188(1976).

From Conference on particle searches and discoveries; Nashville, Tennessee, United States of America (USA) (1 Mar 1976).

See CONF-760344—.

A brief summary of the results of an experiment conducted by the Caltech-Fermilab group in October 1974 to study the structure of the neutral current is given.

4082 Anomalies in ν, antiν interactions. Benvenuti, A.; Cline, D.; Ford, W.T. (Univ. of Wisconsin, Madison). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 30, 189-205(1976).

From Conference on particle searches and discoveries; Nashville, Tennessee, United States of America (USA) (1 Mar 1976).

See CONF-760344—.

The state of the large y anomaly is evaluated following a detailed study of the resolution and the detection efficiency of the apparatus. A new measurement of the cross-section ratio sigma/sub c/(anti ν)/sigma/sub c/(ν) at high energies is presented.

4083 New phenomena in ν interactions. Camerini, U.; Cline, D.; Fry, W. (Univ. of Wisconsin, Madison). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 30, 206-216(1976).

From Conference on particle searches and discoveries; Nashville, Tennessee, United States of America (USA) (1 Mar 1976).

See CONF-760344—.

Several events were observed in neutrino interactions which have an e^+ and a K°/sub s/ decay in the final state along with the conventional μ^-. A discussion of their detection and relation to dimuon events will be presented. The significance of the associated strange particles and related kinematic quantities will be discussed.

4084 Search for new particle production in a νH_2 experiment and in a antiνH_2—Ne experiment in the 15-foot bubble chamber. Scott, W.G. (Fermi National Accelerator Lab., Batavia, IL). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 30, 217-228(1976).

From Conference on particle searches and discoveries; Nashville, Tennessee, United States of America (USA) (1 Mar 1976).

See CONF-760344—.

Searches for evidence for new particle production in the Berkeley-Fermilab-Hawaii-Michigan neutrino hydrogen experiment and in the Fermilab-ITEP-Michigan-Serpukhov antineutrino hydrogen-neon experiment are discussed.

STRONG BARYON-INDUCED INTERACTIONS

REFER ALSO TO CITATION(S) 4069, 4071, 4072, 4098, 4099

4085 (BNL—21124) **Implications for new particle searches of some cosmic ray emulsion events.** Gaisser, T.K. (Brookhaven National Lab., Upton, N.Y. (USA); Bartol Research Foundation, Swarthmore, Pa. (USA)). Mar 1976. 5p. (CONF-760344—3). Dep. NTIS $3.50.

From Conference on particle searches and discoveries; Nashville, Tennessee, United States of America (USA) (1 Mar 1976).

Calculations of backgrounds for cosmic ray candidates for new particles in emulsions are summarized. Even if only the strongest cosmic ray candidates are accepted as genuine, the implication is that their production cross sections would be relatively large at accelerator energies (greater than or equal to 1μb) and that decay modes with π^0 appear to be prominent. Current accelerator upper bounds on sigma x B/sub K pi/ for production of hadrons with M greater than 2 GeV and the relation between these bounds and the cosmic ray events are discussed.

4086 (BNL—21621) **Study of low mass anti pp pairs produced in n—Be interactions.** Carroll, A.S.; Chiang, I.H.; Kycia, T.F.; Li, K.K.; Littenberg, L.; Mazur, P.O.; de Brion, J.P.; Carithers, W.C. (Brookhaven National Lab., Upton, N.Y. (USA); Rochester Univ., N.Y. (USA)). 1976. Contract E(30-1)-16. 9p. (CONF-760725—1). Dep. NTIS $3.50.

From 3. European symposium on antinucleon nucleon interactions; Stockholm, Sweden (9 Jul 1976).

A search was conducted for narrow resonances in the anti pp mass spectrum from threshold to 2700 MeV in a production experiment. Mass spectra of the K^+K^- and K^-p states were also extracted from the data, and known resonances were used to check the mass resolution. With a sample of 8393 anti pp pairs, no statistically significant narrow structures were observed.

4087 (COO—3069-404) **Search for new particles at BNL.** Chen, M. (Massachusetts Inst. of Tech., Cambridge (USA)). 1976. Contract E(11-1)-3069. 33p. (CONF-760124—3). Dep. NTIS $4.00.

From Conference of the ORBIS SCIENTIAE, center for theoretical studies; Coral Gables, Florida, United States of America (USA) (19 Jan 1976).

The various cross sections and distributions are presented for a search for charmed particles in proton reactions with beryllium. (JFP)

4088 Search for new particles below 50 GeV. Chen, M. (Massachusetts Inst. of Tech., Cambridge). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 30, 13-29(1976).

From Conference on particle searches and discoveries; Nashville, Tennessee, United States of America (USA) (1 Mar 1976).

See CONF-760344—.

A systematic search for charm particles was made using the MIT-BNL double arm spectrometer, in the h^+h^-, $h^+h^-\mu$ and h/sup +-/ e/sup +-/ final states with 28.5-GeV incident proton beam interacting on Be target. No evidence was found in any of the reactions.

4089 Search for new states which decay semi-leptonically. Cook, V. (Univ. of Washington, Seattle); Csorna, S.; Holmgren, D. *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 30, 83-87(1976).

From Conference on particle searches and discoveries; Nashville, Tennessee, United States of America (USA) (1 Mar 1976).

See CONF-760344—.

The results of a search for new particle production with decay modes which include neutral strange particles and muons are reported. The number of neutral strange particles produced by interactions of a 225-MeV pion beam on a nuclear target was measured when muons were and were not required in the final states. It was concluded that one does not produce neutral strange particles which are correlated with muons at an observable cross section greater than 1 nb in the 2μ . E trigger. This result can be used to place limits on charmed particle production. (JFP)

4090 Study of prompt muons and associated particles in n—Be collisions. Ruchti, R.C. (Northwestern Univ., Evanston, IL). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 30, 88-93(1976).

From Conference on particle searches and discoveries; Nashville, Tennessee, United States of America (USA) (1 Mar 1976).

See CONF-760344—.

One is currently studying the associated production of prompt muons and other particles produced in n-Be collisions in the M-3 neutral beam at Fermilab. The muon arm of our two-arm spectrometer provides excellent hadron rejection and accepts particles of transverse momentum greater than 0.35 GeV/c. The muon momentum is measured with an accuracy of about +-25 percent.

The precision forward arm of the spectrometer has large acceptance (x greater than 0.2) and is instrumented with equipment for lepton identification. The system is triggered whenever one or more charged particles traverse the muon arm in conjunction with at least one charged particle in the forward arm. Preliminary distributions for particles in the muon arm are presented.

4091 Search for narrow high mass states at Fermilab. Abolins, M.A. (Michigan State Univ., East Lansing); Cardimona, D.; Matthews, J.A.J.; Sidwell, R.A.; Barton, H.R. Jr.; Reay, N.W.; Reibel, K.; Stanton, N.; Edwards, K.W.; Luxton, G. *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 30, 102-106(1976).

From Conference on particle searches and discoveries; Nashville, Tennessee, United States of America (USA) (1 Mar 1976).

See CONF-760344—.

A search was made in neutron beryllium interactions for neutral narrow enhancements produced at Feynman x approximately greater than 0.2. Upper limits are presented for production cross sections times branching ratio into the 2-body channels $\pi^+\pi^-$, π^+K^-, pK^- and p anti p for masses in the interval 2 GeV approximately less than m approximately less than 4 GeV.

STRONG MESON-INDUCED INTERACTIONS

REFER ALSO TO CITATION(S) 4068, 4069, 4073, 4076, 4085, 4088, 4089

4092 (COO—1428-438) **Measurement of the energy dependence of π^-p yields $p\pi^-$ and π^-p yields $\Delta^+(1236)\pi^-$ near the backward direction between 3.0 and 5.5 GeV/c.** Dixon, R.L.; Fletcher, J.M.; Garfinkel, A.F.; Loeffler, F.J.; Mudrak, S.; Shibata, E.I.; Stanfield, K.C.; Tang, Y.W.; Hoffman, E.W. (Purdue Univ., Lafayette, Ind. (USA). Dept. of Physics; Argonne National Lab., Ill. (USA)). 1976. Contract E(11-1)-1428. 6p. (CONF-760729—1). Dep. NTIS $3.50.

From Topical conference on Baryon Resonances; Oxford, United Kingdom of Great Britain and Northern Ireland (UK) (5 Jul 1976).

Differential cross sections were measured for π^-p yields $p\pi^-$ and π^-p yields $\Delta^+(1236)\pi^-$ in the four-momentum transfer interval -0.05 greater than u' greater than -0.6 (GeV/c)^2 at 14 beam momenta between 3.0 and 5.5 GeV/c. The energy dependences of both reactions in this u'-interval exhibit broad fluctuations. The narrow baryon resonance at 3245 MeV/c^2 reported by Kormanyos et al. is not observed in these data. The elastic scattering data were also examined for the existence of Ericson fluctuations.

4093 (COO—1545-191) **High-statistics search for A^0_1 and H^0 in π^-p yields $\pi^+\pi^-\pi^0$ at 8.4 GeV/c.** Edwards, K.W.; Legacey, D.; Brockman, P.; Gandsman, J.; Patel, P.M.; Zanfino, C.; Stanton, N.R.; Dankowych, J.A.; Martin, J.F.; Prentice, J.D. (Carleton Univ., Ottawa, Ontario (Canada). Dept. of Physics; McGill Univ., Montreal, Quebec (Canada). Dept. of Physics; Ohio State Univ., Columbus (USA). Dept. of Physics; Toronto Univ., Ontario (Canada). Dept. of Physics). 1976. Contract E(11-1)-1545. 13p. (CONF-760719—4). Dep. NTIS $3.50.

From 18. international conference on high energy physics; Tbilisi, Union of Soviet Socialist Republics (USSR) (15 Jul 1976).

A search is made for the hitherto unobserved neutral J/sup P/ = 1^+ objects A_1^0 and H^0 produced in the reaction π^-p yields $\pi^+\pi^-\pi^0$ yields $\gamma\gamma$ n at 8.4 GeV/c. Both charged pions and both γ's are measured in the Charged and Neutral Spectrometer at the Argonne ZGS. Preliminary results from a first-pass analysis of 45 percent of the data, containing approximately 900 events/10MeV/c^2 mass bin at 1100 MeV/c^2 are reported. Strong peaks at the eta, ω, A_3, and ω(1670) dominate the spectrum. The possible presence of less prominent structure is discussed.

4094 (COO—1545-192) **Production of eta', D and E mesons in π^-p yields eta $\pi^+\pi^-n$ at 8.4 GeV/c.** Edwards, K.W.; Legacey, D.; Brockman, P.; Gandsman, J.; Patel, P.M.; Zanfino, C.; Stanton, N.R.; Dankowych, J.A.; Martin, J.F.; Prentice, J.D. (Carleton Univ., Ottawa, Ontario (Canada). Dept. of Physics; McGill Univ., Montreal, Quebec (Canada). Dept. of Physics; Ohio State Univ., Columbus (USA). Dept. of Physics; Toronto Univ., Ontario (Canada). Dept. of Physics). 1976. Contract E(11-1)-1545. 12p. (CONF-760719—5). Dep. NTIS $3.50.

From 18. international conference on high energy physics; Tbilisi, Union of Soviet Socialist Republics (USSR) (15 Jul 1976).

Preliminary results are reported from a study of π^-p yields eta$\pi^+\pi^-$n (eta yields $\gamma\gamma$) at 8.4 GeV/c, using the charged and neutral spectrometer at the Argonne ZGS. Both charged particles and both γ's are measured by the apparatus. The data presented from a first-pass analysis of 45 percent of the sample, contain 1,770 eta' (958), 240 D(1285) and a suggestion of E(1420). Cascade decays via sigma(980) yields etaπ will be discussed. A very clean sample of D(1285) is obtained by a suitable etaπ mass cut.

4095 (COO—1545-193) **Comparison of the differential cross-sections for π^-p yields eta'n and π^-p yields eta n at 8.4 GeV/c.** Edwards, K.W.; Legacey, D.; Brockman, P.;Gandsman, J.; Patel, P.M.; Zanfino, C.; Stanton, N.R.; Dankowych, J.A.; Martin, J.F.; Prentice, J.D. (Carleton Univ., Ottawa, Ontario (Canada). Dept. of Physics; McGill Univ., Montreal, Quebec (Canada). Dept. of Physics; Ohio State Univ., Columbus (USA). Dept. of Physics; Toronto Univ., Ontario (Canada). Dept. of Physics). 1976. Contract E(11-1)-1545. 11p. (CONF-760719—1). Dep. NTIS $3.50.

From 18. international conference on high energy physics; Tbilisi, Union of Soviet Socialist Republics (USSR) (15 Jul 1976).

Preliminary data are presented based on 45 percent of the sample, from a simultaneous study of π^-p yields eta'n, eta' yields eta$\pi^+\pi^-$, eta yields $\gamma\gamma$, (1770 events) and π^-p yields eta$n\pi^0\pi^+\pi^-$ yields $\gamma\gamma$, (3250 events) at 8.4 GeV/c, covering a range of momentum transfer t' from 0 to 1.7 (GeV/c)^2. Both charged pions and both γ's from each reaction were measured in the charged and neutral spectrometer at the Argonne ZGS. Backgrounds are 2 to 5 percent. The shapes of dsigma/dt for the two reactions are found significantly different, the eta' having considerably less forward turnover. The ratio of dsigma/dt at $t' = 0$ is (within present understanding of the systematics) consistent with a simple quark model and quadratic mixing angle approximately -10°.

4096 Search for new particles at the CERN ISR. McCubbin, N.A. (Rutherford Lab., Didcot, Eng.). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 30, 38-50(1976).

From Conference on particle searches and discoveries; Nashville, Tennessee, United States of America (USA) (1 Mar 1976).

See CONF-760344—.

The results of an experiment performed at the CERN ISR to search for new particles, produced in pp collisions at $\sqrt{s} = 53$ GeV, which decay into two long-lived hadrons (i.e., π^+, π^-, K^+, K^-, p or anti p).

4097 Charmed particle searches using bubble chambers with hadronic beams. Harris, R. (Fermi National Accelerator Lab., Batavia, IL). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 30, 51-56(1976).

From Conference on particle searches and discoveries; Nashville, Tennessee, United States of America (USA) (1 Mar 1976).

See CONF-760344—.

Searches for charmed particle production using bubble chambers with hadronic beams are summarized. These searches depend on the detection of neutral strange particles. Upper limits are given for long-lived particles (t/sub c/ greater than 10^{-11} sec), for short-lived particles showing up in mass distributions and for semi-leptonic decays involving μ's plus V's.

4098 Implications for new particle searches of some cosmic ray emulsion events. Gaisser, T.K. (Brookhaven National Lab., Upton, NY). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 30, 57-61(1976).

From Conference on particle searches and discoveries; Nashville, Tennessee, United States of America (USA) (1 Mar 1976).

See CONF-760344—.

Calculations of backgrounds for cosmic ray candidates for new particles in emulsions are summarized. Even if only the strongest cosmic ray candidates are accepted as genuine, the implication is that their production cross sections would be relatively large at accelerator energies (approximately greater than 1 μb) and that decay modes with π^0 appear to be prominent. Current accelerator upper bounds on sigma x B/sub Kπ/ for production of hadrons with M greater than 2 GeV are considered and the relation between these bounds and the cosmic ray events is discussed.

4099 Dimuon production by pions and protons in iron and a search for the production in hydrogen of new particles which decay into muons. Blanar, G.J. (CERN, Geneva); Boyer, C.F.; Faissler, W.L. *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 30, 94-101(1976).

From Conference on particle searches and discoveries; Nashville, Tennessee, United States of America (USA) (1 Mar 1976).

See CONF-760344—.

Dimuon production cross sections were measured with a 200 GeV π^- beam and a 240 GeV proton (p) beam. The dimuon mass spectra produced by π and p have essentially the same shape. The dimuon transverse momentum behavior is essentially the same for vector mesons produced by π or by p. For (rho + ω) or psi production the x (Feynman) behavior is approximately indepen-

dent of the mass of the dimuon produced. The dimuon π production cross section is approximately 6 times greater than that of the p for x greater than .5. Using a missing mass (M/sub m/) technique, the same pion and proton beams were used to search for the production in hydrogen of new particles which decay with muon emission. Model dependent upper limits (50 to 7000 nanobarns) for the production of such objects with 2.5 less than M/sub m/ less than 7. GeV are given (for charmed meson pair production M/sub m/ is the mass of the D anti D system).

4100 psi and psi' decays and intermediate states: results from SPEAR, LBL-SLAC. Friedberg, C.E. (Univ. of California, Berkeley). *AIP (Am. Inst. Phys.) Conf. Proc.*; No. 30, 229-247(1976).

From Conference on particle searches and discoveries; Nashville, Tennessee, United States of America (USA) (1 Mar 1976).

See CONF-760344—.

The properties and decay of the psi(3105) and psi(3695) resonances are reviewed. Included are branching ratios, masses, spins, parities, and widths. (JFP)

4101 Results from DORIS: neutral detector. Bartel, W.; Duinker, P.; Olsson, J.E. (Deutsches Elektronen-Synchrotron, Hamburg). *AIP (Am. Inst. Phys.) Conf. Proc.*; No. 30, 274-284(1976).

From Conference on particle searches and discoveries; Nashville, Tennessee, United States of America (USA) (1 Mar 1976).

See CONF-760344—.

The apparatus of the DESY-Heidelberg group is described. Preliminary results of a recent data evaluation are presented. In the investigation of the two photon cascade psi'(3.7) yields γ + P/sub c/, P/sub c/ yields γ + J/psi(3.1), about 60 events are found with J/psi yields $\mu^+\mu^-$ or e^+e^-. The angular distributions of the γ-rays with respect to the beam axis indicate that the intermediate state P/sub c/ has nonzero spin and the mass M(P/sub c/) = (3.51 +- 0.02) GeV, while the solution M(P/sub c/) = 3.26 GeV seems to be excluded. From a study of total neutral decays of J/psi(3.1) an upper limit of 1.2 percent for the neutral radiative decays is obtained.

PARTICLE INTERACTIONS AND PROPERTIES - THEORETICAL

GENERAL

REFER ALSO TO CITATION(S) 4121, 4171

4102 (FERMILAB-Conf—76/30-THY) **Postlude.** Quigg, C. (Fermi National Accelerator Lab., Batavia, Ill. (USA)). Mar 1976. (CONF-760344—1). Dep. NTIS $3.50.

From Conference on particle searches and discoveries; Nashville, Tennessee, United States of America (USA) (1 Mar 1976).

The results of a critical reading of papers presented are given. Included are hadronic production of new particles and leptons, charm, neutrino-induced production of charm, and psi spectroscopy. (JFP)

ELECTROMAGNETIC INTERACTIONS

REFER ALSO TO CITATION(S) 4108

4103 Review of theoretical ideas on prompt lepton production. Sullivan, J.D. (Univ. of Illinois, Urbana). *AIP (Am. Inst. Phys.) Conf. Proc.*; No. 30, 142-161(1976).

From Conference on particle searches and discoveries; Nashville, Tennessee, United States of America (USA) (1 Mar 1976).

See CONF-760344—.

The different physical mechanisms which have been proposed for direct lepton production in hadron-hadron interactions are reviewed. Emphasis is placed on electromagnetic processes which are better studied theoretically and an important, though perphaps not exclusive, source of direct leptons.

WEAK INTERACTIONS

REFER ALSO TO CITATION(S) 4032

4104 (BNL—21468) **Weinberg—Salam gauge model and neutrino proton elastic scattering.** Sidhu, D.P. (Hanford Engineering Development Lab., Richland, Wash. (USA)). 9 Aug 1976. Contract E(30-1)-16. 12p. Dep. NTIS $3.50.

Elastic scattering of neutrino on proton is studied in the Weinberg-Salam gauge model of neutral currents. Particular attention is paid to the experimental cuts relevant to two recent BNL experiments and spectra averaging so that model predictions can be directly compared to the experimental data. The uncertainty in the calculation due to changes in the parameters which are not well determined such as the mass of the axial vector meson is emphasized. It is concluded that the simple Weinberg-Salam gauge model with $\sin^2$ theta/sub W/ approximately 0.4 is consistent with the recent measurement of R/sub el/sup nu/ = less than sigma((nu + p yields nu + p) greater than/less than sigma(nu + n yields μ^- + p) greater than provided M/sub A/ approximately 1.15 GeV which is within the range of uncertainty of this parameter. Similar calculation for the case of antineutrino proton elastic scattering, i.e., R/sub el/sup anti nu/ = less than sigma (anti nu + p yields anti nu + p) greater than/less than sigma (anti nu + p yields μ^+ + n) greater than is presented. (JFP)

4105 (FERMILAB-Conf—76/50-THY) **Inclusive charged current neutrino reactions: implications for gauge models with heavy quarks and right-handed currents.** Albright, C.H.; Shrock, R.E. (Fermi National Accelerator Lab., Batavia, Ill. (USA)). Jun 1976. Contract AT(49-8)-3000. 37p. (CONF-760719—8). Dep. NTIS $4.00.

From 18. international conference on high energy physics; Tbilisi, Union of Soviet Socialist Republics (USSR) (15 Jul 1976).

The predictions of several gauge theory models for deep inelastic neutrino reactions on both isoscalar and proton targets are analyzed. In particular, y and W distributions, mean values of various kinematic quantities, and total cross sections are calculated. The effects of heavy quark production and the possible excitation of right-handed currents are discussed. In addition to the Weinberg-Salam and vector models, one studies certain six-quark models which have parity-violating neutral currents. Estimates of effective heavy quark masses are presented for each model.

4106 Prompt positrons at AGS energies-report on the Penn—Stony Brook experiment. Beier, E.W. (Univ. of Pennsylvania, Philadelphia); Patton, R.; Raychaudhuri, K. *AIP (Am. Inst. Phys.) Conf. Proc.*; No. 30, 109-115(1976).

From Conference on particle searches and discoveries; Nashville, Tennessee, United States of America (USA) (1 Mar 1976).

See CONF-760344—.

Prompt positrons are observed at beam momenta of 10, 15, and 24 GeV/c near 90^0 in the c.m. The signal was found to be largest at the lowest p/sub perpendicular/ measured (0.55 GeV/c), where e^+/π^- greater than 1×10^{-4}. For 0.8 GeV/c less than p/sub perpendicular/ less than 1.5 GeV/c vector meson decays may be sufficient to account for the positrons observed.

STRONG INTERACTIONS, GENERAL

REFER ALSO TO CITATION(S) 4103, 4120

4107 (RLO—2041-150) **Space—time implication of hadron correlation.** Hwa, R.C. (Oregon Univ., Eugene (USA)). Nov 1975. Contract AT(45-1)-2230. 19p. (OITS—75-35). Dep. NTIS $3.50.

The concept that the two-particle correlation among produced pions in high energy collisions is long-ranged is advanced. The space-time properties of the hadronic fluid before break-up are stressed. By examining the Lehmann representation of the correlation function, it is shown that the spectral function must have a singularity at m = 0, corresponding to a zero-mass excitation. The correlation length in rapidity is related to the nature of that singularity.

STRONG INTERACTIONS, BARYON NO. 0

4108 (RLO—2041-131) **Some meson coupling constants in broken SU(4) and the radiative decays of phi/sub c/ and eta/sub c/.** Aubrecht, G.J. II; Razmi, M.S.K. (Oregon Univ., Eugene (USA)). Mar 1975. Contract E(45-1)-2230. 12p. Dep. NTIS $3.50.

Vector-pseudoscalar-pseudoscalar and vector-vector pseudoscallar coupling constants are calculated in broken SU(4) using current algebra and PCAC. As applications of results estimates of the decay widths GAMMA(phi/sub c/ yields $x^a\gamma$), GAMMA(phi/sub c/ yields eta/sub c/γ) and GAMMA(eta/sub c/ yields 2γ) are presented.

4109 Comments on the new particles. Appelquist, T. (Yale Univ., New Haven). *AIP (Am. Inst. Phys.) Conf. Proc.*; No. 30, 62-74(1976).

From Conference on particle searches and discoveries; Nashville, Tennessee, United States of America (USA) (1 Mar 1976).

See CONF-760344—.

The spectroscopy and decays of the new particles are reviewed from the point of view of the charmonium model. The review proceeds from general features expected to be true in a wide class of spin $^1/_2$ constituent models to predictions that depend in more detail on the dynamics of the color SU(3) quark gluon theory. A list of important and unresolved problems is presented at the end.

STRONG INTERACTIONS, BARYON NO. 1

REFER ALSO TO CITATION(S) 4112

4110 (COO—2171-59) **Meson-nuclear physics: a preview.** Koltun, D.S. (Rochester Univ., N.Y. (USA)). 1976. Contract E(11-1)-2171. 8p. (CONF-760561—10). Dep. NTIS $3.50.

From International topical conference on meson-nuclear physics; Pittsburgh, Pennsylvania, United States of America (USA) (24 May 1976).

The purpose of this Preview is to provide a quick guide to the main topics of this Conference, pointing out some highlights of the days to come. It differs from a Preview in the cinema or theater, which is put together from the finished production, and is meant to give you a sense of the drama (or comedy) to follow. No one here has seen or heard the finished production of the conference; it doesn't yet exist. What I have seen is the Conference Program and the contributed papers, and base my remarks on them. If my remarks do not correspond precisely to what the speakers will actually say, no apology is called for. After all, this is not a Conference Summary. I have divided the subject into several general categories, corresponding to the main areas of this conference, but I shall not follow the order of the program. In the interests of economy I have not given references; the "reviews", "discussions" and "contributions" mentioned in what follows may be located in the Conference Program, or in the Contributed Papers. In some case I have included the name of the relevant speaker, in brackets.

STRONG INTERACTIONS, BARYON NO. GREATER THAN 1

REFER ALSO TO CITATION(S) 4173

4111 (BNL—21464) **Interpretation of pion—nucleus total cross sections in the region of the πn (3,3) resonance.** Dover, C.B. (Brookhaven National Lab., Upton, N.Y. (USA)). 1976. Contract E(30-1)-16. 11p. (CONF-760561—8). Dep. NTIS $3.50.

From International topical conference on meson-nuclear physics; Pittsburgh, Pennsylvania, United States of America (USA) (24 May 1976).

Some aspects of the problem of the interaction of a probe with a nucleus in the energy region where the elementary probe-nucleon interaction resonates are considered. The case of pion-nucleus scattering is treated as an illustration.

4112 (COO—3001-149) **Overview of the N—N system.** Brown, G.E. (State Univ. of New York, Stony Brook (USA)). 1976. Contract AT(11-1)-3001. 6p. (CONF-760561—9). Dep. NTIS $3.50.

From International topical conference on meson-nuclear physics; Pittsburgh, Pennsylvania, United States of America (USA) (24 May 1976).

Components other than the one-pion exchange play a role in the interactions of nucleons which are important in pion-nucleon scattering. Especially the rho-meson exchange interaction is crucial in a realistic description.

4113 (RLO—2041-136) **Energy scales and diffraction scattering.** Dash, J.W.; Koplik, J. (Oregon Univ., Eugene (USA); Columbia Univ., New York (USA). Dept. of Physics). Jan 1975. Contract E(45-1)-2041. 18p. (COO—2271-45(Rev.)). Dep. NTIS $3.50.

The influence of threshold on models of diffraction scattering is considered. The experimental existence of effective inelastic diffraction and baryon-antibaryon thresholds to conjecture a relation between the bare Pomeron P/sup G/ of the Gribov calculus, the bare Pomeron P/sup E/ of recent fits to NAL-ISR elastic data, and a bare Pomeron P of intercept α_0 approximately equal to 0.85 utilized in medium energy two-body and high energy inclusive phenomenology. A set of energy scales is set up describing approximate regions of validity of various models for diffraction, including the Gribov calculus. An iterative approximation scheme to the s and t channel unitarity equations at small t and large s is described.

PARTICLE INVARIANCE PRINCIPLES AND SYMMETRIES

APPLICATIONS TO ELECTROMAGNETIC AND WEAK INTERACTIONS

4114 (ORO—3992-276) **SU(3)/sub E/ invariant form factor for pseudoscalar mesons.** Bohm, A.; Igarashi, M.; Werle, J. (Texas Univ., Austin (USA). Center for Particle Theory). Jun 1976. Contract E(40-1)-3993. 18p. Dep. NTIS $3.50.

The use of a form factor which is invariant with respect to the spectrum generating SU(3) leads to a definition for the strangeness changing suppression factor for K/sub l_3/ decay which is numerically equal to the strangeness changing suppression factor for K/sub l_2/ decay and close to (m/sub π/)/(m/sub k/). It also predicts the electromagnetic radius of the pseudoscalar mesons in terms of lambda/sub +/.

4115 (RLO—2041-132) **K/sub l3/ form factors and the (8,8) model of chiral symmetry breaking-unitarized version.** Ali, A.; Razmi, M.S.K. (Stevens Inst. of Tech., Hoboken, N.J. (USA). Dept. of Physics; Oregon Univ., Eugene (USA). Inst. of Theoretical Science). Apr 1975. Contract E(45-1)-2230. 20p. Dep. NTIS $3.50.

K/sub l_3/ form factors are studied in an analytic hard-meson approach, using the (8,8) model of chiral SU(3) x SU(3) symmetry breaking. The divergence form factor is required to show resonance behavior near the kappa meson mass. The ensuing resonance conditions are used to express lambda_0, the slope of the divergence form factor and GAMMA/sub JC/, the kappa width, in terms of the kappa mass. A considerable suppression of lambda_0 below its Callan-Treiman value can be obtained. Comparison is made with a previous analysis of K/sub l_3/ decay using the (3,3*) + (3*,3) model of symmetry breaking. It is suggested that one cannot rule out the (8,8) model in favor of the (3,3*) + (3*,3) at present.

APPLICATIONS TO STRONG INTERACTIONS

4116 (RLO—2041-129) **Supersymmetry of hadron multiplets.** Hwa, R.C.; Lam, C.S. (Oregon Univ., Eugene (USA); McGill Univ., Montreal, Quebec (Canada). Dept. of Physics). Jan 1975. Contract E(45-1)-2230. 26p. Dep. NTIS $4.00.

The supersymmetry algebra of Wess and Zumino was generalized to incorporate explicitly the baryon number operator. Constraints on the algebraic structure due to the finite dimensionality of its representations were determined. In the rest frame where the supersymmetry generator has only two components, it is shown that an irreducible representation cannot have more than three adjacent baryon numbers. The octet representations in the (B,J_3) space for various SU(3) states are shown to accommodate most of the prominent hadrons. The product representation of two octets has been reduced to an irreducible octet component, and the consequences on the coupling constants were determined. The implication on the couplings among the physical hadrons is discussed.

4117 (RLO—2041-130) **Model for πp, Kp, and psi p total cross section ratios.** Teper, M.; Dash, J.W.; Razmi, M.S.K. (Oregon Univ., Eugene (USA). Inst. of Theoretical Science). Mar 1975. Contract AT(45-1)-2230. 8p. Dep. NTIS $3.50.

The ratios of πp, Kp and psi p total cross sections are calculated utilizing coupled homogeneous linear integral equations supplemented with SU(4) symmetry for the couplings. Kinematic effects arising from mass splittings and t/sub min/ effects are crucial. One obtains sigma/sub πp//sigma/sub Kp/ approximately 1.7 and sigma/sub psi p//sigma/sub πp/ approximately $^1/_{50}$.

4118 (RLO—2041-140) **Relativistic supersymmetric hadron multiplets.** Hwa, R.C.; Lam, C.S. (Oregon Univ., Eugene (USA); McGill Univ., Montreal, Quebec (Canada). Dept. of Physics). Jun 1975. Contract AT(45-1)-2041. 30p. (OITS—75-12). Dep. NTIS $4.00.

The supersymmetry scheme for hadrons proposed previously is generalized to the relativistic case. A way is found to limit the generators of the superalgebra to two components while allowing the baryon states to be four-component spinors. The problem of finding the most general product representation of supermultiplets is solved, and the result is expressed in terms of twelve scalar form factors satisfying two conditions. The transformation properties of the octet states under charge conjugation C, parity P, and CP are discussed.

FIELD THEORY

REFER ALSO TO CITATION(S) 4171

4119 (ORO—3992-255) **Explicit calculation versus formal proof concerning unitary violation of unified theories in Wu's gauge.** Hsum, J.P. (Texas Univ., Austin (USA). Center for Particle Theory). 1976. Contract E(40-1)-3992. 11p. Dep. NTIS $3.50.

A formal proof and explicit check of unitarity is presented for non-Abelian gauge theories with a particular bilinear gauge condition, where the theories are constructed within the Lagrange multiplier formalism. (JFP)

4120 **Reggeon field theory: formulation and use.** Abarbanel, H.D.I. (Fermi National Accelerator Lab., Batavia, Ill. (USA)); Bronzan, J.D. (Rutgers--the State Univ., New Brunswick, N.J. (USA). Dept. of Physics); Sugar, R.L. (California Univ., Santa Barbara (USA). Dept. of Physics); White, A.R. (California Univ., Berkeley (USA). Dept. of Physics). *Phys. Rep.*; 21: No. 3, 119-182(Oct 1975).

94 refs.

Reggeon field theory is formulated and discussed which enables one to systematically analyze the exchange of Regge poles and associated branch points in high energy hadron scattering. The field theory is first motivated by a consideration of hybrid Feynman graphs, and then a more general derivation from crossed-channel multiparticle unitarity relations is given. Rules for Reggeon interaction and propagation are formulated. The problem of the Pomeron or vacuum pole which has $\alpha(0)=1$ and is responsible for diffractive processes is treated in some detail. In particular the renormalization group analysis of Reggeon field theory is presented and the structure of Pomeron partial wave amplitudes is elucidated. Also the question of Pomeron or absorptive corrections to secondary trajectories (both fermion and boson) is considered. Some comments are made on important problems yet remaining in Reggeon field theory; in particular, the study of its s-channel content.

SCATTERING THEORY

4121 (RLO—2041-125) **Factorized knowledge from factorized polarization experiments.** Moravcsik, M.J. (Oregon Univ., Eugene (USA)). 1975. Contract E(45-1)-2230. 9p. Dep. NTIS $3.50.

A general analysis is presented which yields a simple and economical picture of the information obtained about the reaction amplitudes from an incomplete set of polarization experiments. Spinwise inclusive ("spinclusive") reactions can thus furnish "spinclusive" used to derive a method to determine the spin of a particle in a reaction without ever measuring anything about that particle.

NUCLEAR PHYSICS

REFER ALSO TO CITATION(S) 4366

4122 (EURFNR—1337) **FANAL: a multi-level shape-analysis program for resonance parameter determination by least-squares fitting of several sets of neutron transmission data simultaneously.** Froehner, F.H. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Neutronenphysik und Reaktortechnik). Jan 1976. 48p. (KFK—2129). Dep. NTIS (US Sales Only) $4.00.

Work performed under United States—Euratom Fast Reactor Exchange Program.

A description is given of a least-squares shape analysis program which is used at the Karlsruhe Nuclear Research Center for the extraction of resonance parameters from neutron transmission data. The program allows simultaneous fitting of up to 5 different experimental data sets, uses the multi-level R-matrix formalism and includes resolution broadening. A listing of the program and examples for input and output are given.

4123 (ORNL—5137) **Physics Division annual progress report for period ending December 31, 1975.** (Oak Ridge National Lab., Tenn. (USA)). May 1976. Contract W-7405-eng-26. 214p. Dep. NTIS $8.00.

Separate abstracts were prepared for each of the data-containing sections of this report. Additional sections deal with publications, titles of papers presented at scientific and technical meetings, personnel, etc. (RWR)

4124 (ORNL—5137, pp 9-88) **Experimental nuclear physics: Oak Ridge Isochronous Cyclotron program.** Gross, E.E. May 1976.

In Physics Division annual progress report for period ending December 31, 1975.

Significant results from the UNISOR project include evidence for coexistence of spherical and deformed bands in ^{186}Hg, new mass determinations by positron endpoint energies or α-decay energies, and a g-factor measurement for the first 2^+ state in ^{136}Xe, using the separator as an ion implantation device. A combination of in-beam γ-ray studies and isotope separator measurements led to a thorough understanding of the roles of the h/sub $^{11}/_2$/-neutron and h/sub $^9/_2$/-proton orbitals throughout the mercury isotopes. The research program has a strong commitment to a systematic investigation of "macroscopic" phenomena in general to "strongly damped" reaction processes in particular. Interesting details are beginning to appear, such as structure in the "deeply inelastic" yields of Z approximately greater than 8 products from 130-MeV ^{12}C bombardment of ^{63}Cu. The "microscopic" heavy-ion reaction continues to show promise as a spectroscopic tool. Two results are outstanding in this regard. One is a clear demonstration that the (^{6}Li,^{6}He) charge-exchange reaction is a reliable probe for Gamow—Teller strength in nuclei. The other is an equally clear demonstration that heavy-ion inelastic scattering can be used as a sensitive probe of nuclear shapes. The latter results from a coupled-channels analysis of 2^+, 4^+, and 3^- states excited by 70-MeV ^{12}C inelastic scattering from ^{142} ^{144} ^{146} ^{148} ^{150}Nd. The areas of transfer reactions, giant resonance excitation, Doppler-shift lifetime determinations, and nuclear chemistry are also represented. 91 figures, 11 tables. (RWR)

4125 **Beta and gamma spectra and total decay energies from fission products.** England, T.R.; Stamatelatos, M.G. (Los Alamos Scientific Lab., NM). *Trans. Am. Nucl. Soc.*; 23: 493-494(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

4126 **Correlation of fission-fragment charge distribution and fragment excitation energy.** Liaw, J.R. (Univ. of Oklahoma, Norman). *Trans. Am. Nucl. Soc.*; 23: 494-495(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

NUCLEAR PROPERTIES AND REACTIONS, A=1-5, THEORETICAL

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 4130

4127 (LA—6389-MS) **Tables of phase shifts and experimental observables for p-^{4}He elastic scattering.** Dodder, D.C.; Hale, G.M.; Jarmie, N.; Witte, K. (Los Alamos Scientific Lab., N.Mex. (USA)). Jun 1976. Contract W-7405-Eng-36. 58p. Dep. NTIS $4.50.

These tables contain calculated phase shifts and experimental observables for p-^{4}He elastic scattering from 0 to 17 MeV. The phase shifts are given at intervals suitable for linear interpolation.

4128 (RLO—1388-297) **Production of Li, Be, and B at low energies.** Bodansky, D.; Jacobs, W.W.; Oberg, D.L. (Washington Univ., Seattle (USA). Dept. of Physics). 10 Apr 1975. Contract E(45-1)-1388. 38p. Dep. NTIS $4.00.

Relative yields of LiBeB isotopes are calculated for proton and α-particle induced reactions at energies in the neighborhood of ten or tens of MeV, and comparisons are made with solar system abundances. A match is found for incident particles in the neighborhood of 16 MeV, assuming the meteoritic value for the B abundance and standard values for other target and product abundances. To obtain matches to a lower than meteoritic B abundance or for protons and α particles at the same energy per nucleon, it is found necessary to alter the initial abundance assumptions or assume selective destruction. The range of possible fits suggests that the nuclear cross sections do not preclude each of the LiBeB isotopes being produced mainly in reactions at the relatively low energies considered here.

NUCLEAR PROPERTIES AND REACTIONS, A=1-5, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 4132, 4135

4129 Maximum tensor analyzing power Asub(yy)=1 in the ^{3}He(d(pol,p)^{4}He reaction. Seiler, F. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). *Phys. Lett., B;* **61**: No. 2, 144-146(15 Mar 1976).

An evaluation of recent polarization measurements of the ^{3}He(d(pol),p)^{4}He reaction shows that the experimental values of the efficiency Asub(yy) reach unity Esub(d)=9 MeV and thetasub(CM)=27°. The use of extreme values in the calibration of polarization and in the analysis of reactions is discussed.

NUCLEAR PROPERTIES AND REACTIONS, A=6-19 THEORETICAL

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 4130

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 4128

4130 (ORO—5126-2) **Nucleon knockout: reaction mechanisms.** Redish, E.F. (Maryland Univ., College Park (USA). Dept. of Physics and Astronomy). Jul 1976. Contract E(40-1)-5120. 32p. (CONF-760567—1). Dep. NTIS $4.00.

From Workshop on the determination of momentum wavefunctions; Bloomington, Indiana, United States of America (USA) (31 May 1976).

The treatment of the reactions mechanisms involved in nucleon knockout concerns the ideas of what actually happens in nucleon knockout, whether the deviations from the simplest plane wave picture interfere with an extraction of the wave function, and whether or not the desire to measure the bound state wave functions blinds one to the possibility of obtaining other interesting information from this reaction or from finding exciting new processes taking place. Included are the plane- and distorted-wave impulse approximations, some failures, and more sophisticated reaction mechanisms. ^{12}C(P,2P) and ^{4}He(P,2P) are discussed covering cross sections and spectroscopic factors.

NUCLEAR PROPERTIES AND REACTIONS, A=6-19, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

4131 (ORO—3924-23) **Angular momentum effects in nuclear reactions. Progress report, August 1, 1975—July 31, 1976.** Natowitz, J.B. (Texas Agricultural and Mechanical Univ., College Station (USA). Cyclotron Inst.). Jul 1976. Contract E(40-1)-3924. 57p. Dep. NTIS $4.50.

Research performed under U.S. ERDA contract E(40-1)-3924 during the period August 1, 1975-July 31, 1976 is reported. Heavy-ion reaction mechanisms and the properties of highly excited nuclei with high angular momenta were studied. Particle identification, mass identification, fragment coincidence, γ-ray multiplicity and charged-particle multiciplicity experiments were used to study the reactions of ^{12}C with ^{12}C ^{27}Al, ^{40}Ca, and Ni targets and the reactions of ^{20}Ne with ^{27}Al targets. Projectile energies ranged from 4 to 16 MeV/amu. Evidence for large rotational energy contribution to the kinetic energies of the products of deep inelastic reactions was obtained. Fragments produced in reactions of 800-MeV protons with uranium were studied at LAMPF. The production of the new isotope ^{31}Mg was confirmed. A list of publications is included.

NUCLEAR PROPERTIES AND REACTIONS, A=20-38, EXPERIMENTAL

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 4131

4132 (ORO—3624-16) **North Carolina State University Nuclear Structure Research at the Triangle Universities Nuclear laboratory.** Seagondollar, L.W.; Waltner, A.W.; Mitchell, G.E.; Tilley, D.R.; Gould, C.R. (North Carolina State Univ., Raleigh (USA)). 31 May 1976. Contract E(40-1)-3624. 68p. Dep. NTIS $4.50.

Research on nuclear structure is summarized. A list of publications is included. (JFP)

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 4131, 4135

4133 Measurement of the neutron total cross section of sodium. Larson, D.C.; Harvey, J.A.; Hill, N.W. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.;* **23**: 496(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

4134 Measurement of some resonance integrals. Sage, L. (U.S. Navy, Old Bethpage, NY); Furr, A.K. *Trans. Am. Nucl. Soc.;* **23**: 501-502(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

NUCLEAR PROPERTIES AND REACTIONS, A=39-58, EXPERIMENTAL

REFER ALSO TO CITATION(S) 4148, 4149, 4177

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 4132

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 4131, 4134

4135 (EURFNR—1336) **Graphical representation of the Herman nuclear data library KEDAK. Part 1. Nonfissile materials.** Goel, B. (Kernforschungszentrum Karlsruhe (Germany, F.R.)). Dec 1975. Translation of KFK—2233. 483p. Dep. NTIS $12.50.

Work performed under United States—Euratom Fast Reactor Exchange Program.

This report presents the nuclear data library KEDAK-3 in graphical form for the non-fissile materials. It is also compared with the KEDAK-2 and the KFKINR set of group constants. 448 figures, 2 tables.

NUCLEAR PROPERTIES AND REACTIONS, A=90-149, THEORETICAL

REFER ALSO TO CITATION(S) 4131, 4132, 4135

4136 Quadrupole deformation parameters of $^{148,\ 152,\ 154}$Sm determined from neutron total cross sections. Shamu, R.E.; Lagrange, C.H. (CEA Centre d'Etudes de Bruyeres-le-Chatel, 92 - Montrouge (France)); Bernstein, E.M.; Ramirez, J.J. (Western Michigan Univ., Kalamazoo (USA)); Tamura, T. (Texas Univ., Austin (USA)); Wong, C.Y. (Oak Ridge National Lab., Tenn. (USA)). *Phys. Lett., B;* **61**: No. 1, 29-32(1 Mar 1976).

Quadrupole parameters of the nuclear potential were determined for $^{148,\ 152,\ 154}$Sm using coupled-channel calculations. The β_2 values for $^{152,\ 154}$Sm are about 10 percent lower than β_2 values for the nuclear charge distribution obtained from Coulomb excitation, electron scattering, and μ-meson X-ray experiments.

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 4152

4137 (ORO—4322-19) **Nuclear spectroscopy. Progress report, August 1, 1975—July 31, 1976.** Sugihara, T.T. (Texas Agricultural and Mechanical Univ., College Station (USA). Cyclotron Inst.). 1976. Contract E(40-1)-4322. 26p. Dep. NTIS $4.00.

Theoretical and experimental research on nuclear spectroscopy is summarized. A list of publications is included. (JFP)

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 4177

4138 Macroscopic and microscopic model analysis of inelastic scattering of 30 MeV polarized protons from ^{90} ^{92}Zr and ^{98}Mo. de Swiniarski, R.; Bagieu, G.; Massaad, M.; Pham, D.L. (Grenoble-1 Univ., 38 (France). Inst. des Sciences Nucleaires); Bedjidiam, M.; Grossiord, J.Y.; Gusakow, M.; Pizzi, J.R. (Lyon-1 Univ., 69 - Villeurbanne (France). Inst. de Physique Nucleaire); Fulmer, C.B. (Oak Ridge National Lab., Tenn. (USA)). *Phys. Lett., B;* **61**: No. 1, 37-40(1 Mar 1976).

Angular distributions for 30 MeV polarized proton inelastic scattering and analyzing powers were measured for low-lying 2^+, 3^-, and 5^- states in ^{90} ^{92}Zr and ^{98}Mo. These are compared with coupled channel collective model and microscopic model calculations.

NUCLEAR PROPERTIES AND REACTIONS, A=90-149, EXPERIMENTAL

RADIOACTIVE DECAY

4139 Decay of the ^{134}Cs isomers and the levels of ^{134}Xe, ^{134}Cs, and ^{134}Ba. van Hise, J.R. (Pacific Union Coll., Angwin, Calif. (USA). Dept. of Chemistry); Camp, D.C.; Meyer, R.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). *Z. Phys., A;* **274**: No. 4, 383-389(Oct 1975).

7 figs.; 5 tabs.; 44 refs.

A precision study of the decay of ^{134}Cs/sup g/ and ^{134}Cs/sup m/ has been made, using ordinary Ge(Li) spectrometers and a Compton-suppression spectrometer. The log ft value of the second forbidden nonunique β-decay to ^{134}Xe has been measured to be 13.0 +- 0.2. The M4 γ-ray transition on ^{134}Cs/sup m/(8^-) decay has been measured to have $\alpha(K) = 73 +- 7$ and a hindrance of 7.0 over the Moskowski estimate. This is discussed in terms of the level configurations and the analogous transition in ^{133}Xe. A new intensity limit of 2×10^{-6} has been set for the zero-phonon transition between the 4^+ and 2^+ members of the two-phonon triplet. This leads to an upper limit for B(E2, 4 yields 2^+) greater than 905. This and the more precise γ-ray intensity values are discussed in relation to presently available nuclear models.

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 4137, 4139

4140 Nuclear Data Sheets for A = 102. Auble, R.L. (Oak Ridge National Lab., TN); Todd, R.R.; Samuelson, L.E.; Kelly, W.H.; McHarris, W.C. *Nucl. Data Sheets;* **19**: No. 1, 1-32(Sep 1976).

Nuclear structure data available through January 1976 are compiled, and adopted level properties are given. The bulk of the data is presented pictorially for easy comparison. Experimental details, references, and additional comments, where required, are given in the text. All drawings, tables, and comments are reproduced from the computerized Evaluated Nuclear Structure Data File (ENSDF). Any additions or corrections desired by the users should be addressed to the compilers for maintenance and updating of the computer file.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 4134, 4135

4141 (AAEC/E—367) keV neutron capture in zirconium-91. Boldeman, J.W.; Allen, B.J.; Musgrove, A.R.deL.; Macklin, R.L. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Jan 1976. Contract W-7405-eng-26. 13p. Dep. NTIS $3.50.

The neutron capture cross section of ^{91}Zr was measured with high resolution ($\Delta E/E$ approximately 0.2 percent) between 3 and 30 keV. Values of the g GAMMA/sub n/GAMMA/sub γ/GAMMA for 119 resonances in this energy range were obtained. The average capture cross section is consistent with values of (GAMMA/sub γs/) = (GAMMA/sub γp/) = 200.

4142 (COO—2479-9) Precision neutron cross section measurments in support of the LMFBR Program. Annual progress report, 1 July 1975—30 June 1976. Block, R.C.; Hockenbury, R.W. (Rensselaer Polytechnic Inst., Troy, N.Y. (USA)). 1976. Contract E(11-1)-2479. 5p. Dep. NTIS $3.50.

Experimental research on neutron reactions is summarized. A list of publications is included. (JFP)

4143 Fast-neutron excitation of isomeric states in indium. Smith, D.L.; Meadows, J.W. (Argonne National Lab., IL). *Nucl. Sci. Eng.;* **60**: No. 3, 319-322(Jul 1976).

Activation techniques were employed in measurements of cross sections for excitation of the 99.4-min isomeric state at 0.392 MeV in ^{113}In and the 4.5-h isomeric state at 0.335 MeV in ^{115}In from near threshold to approximately 10 MeV. Effective cross sections for these processes in standard fission neutron spectra were also computed from these data.

NUCLEAR PROPERTIES AND REACTIONS, A=150-189, THEORETICAL

REFER ALSO TO CITATION(S) 4136

NUCLEAR PROPERTIES AND REACTIONS, A=150-189, EXPERIMENTAL

ENERGY LEVELS AND TRANSITIONS

4144 Nuclear Data Sheets for A = 151. Harmatz, B. (Oak Ridge National Lab., TN). *Nucl. Data Sheets;* **19**: No. 1, 33-102(Sep 1976).

The literature on all nuclei with mass number A = 151 has been reviewed, and the nuclear structure information is summarized here. The level properties obtained from various reaction and decay experiments are shown in the drawings, and Nilsson—state assignments are given.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 4134

4145 (BNL—21268) Quasielastic and fission total cross sections for ^{16}O on ^{181}Ta and ^{208}Pb. Videbaek, F.; Goldstein, R.B.; Grodzins, L.; Steadman, S.G.; Belote, T.A.; Garrett, J.D. (Hanford Engineering Development Lab., Richland, Wash. (USA)). 1976. Contract E(30-1)-16. 8p. (CONF-760424—18). Dep. NTIS $3.50.

From Symposium on macroscopic features of heavy ion collisions; Argonne, Illinois, United States of America (USA) (1 Apr 1976).

The total quasielastic (inelastic plus few nucleon transfer) and fission cross sections were measured for ^{16}O + ^{208}Pb at incident energies of 80, 83, 88, 90, 96, and 102 MeV and for ^{16}O + ^{181}Ta at incident energies of 83, 90 and 96 MeV. The total quasielastic cross sections account for about 50 percent of the total ^{16}O + ^{208}Pb reaction cross section at the lowest incident energy which is near the Coulomb barrier. At the highest incident energy the ^{16}O + ^{208}Pb quasielastic cross section still accounts for 25 percent of the total cross section. The measured ratio of quasielastic to total cross section for ^{16}O + ^{181}Ta is less than for ^{16}O + ^{208}Pb; however, in the case of the ^{181}Ta target the inelastic transitions to the low lying levels in ^{181}Ta were not resolved from elastic scattering. Within the uncertainties of the measurements the sum of the measured quasielastic and fission cross sections for ^{16}O on ^{208}Pb accounts for the total reaction cross section, indicating that the probability of fission of the ^{224}Th compound and Th daughter systems is large. In contrast for ^{16}O + ^{181}Ta (^{197}Tl compound system) the fission and quasielastic channels account for only a small fraction of the total reaction cross section.

4146 (COO—3122-10) Studies of nuclear reactions. Progress report, September 1, 1975—August 31, 1976. Miller, J.M. (Columbia Univ., New York (USA)). Jun 1976. Contract E(11-1)-3122. 6p. Dep. NTIS $3.50.

Experimental research on nuclear reactions is summarized. A list of publications is included. (JFP)

SPONTANEOUS AND INDUCED FISSION

REFER ALSO TO CITATION(S) 4145

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 4148, 4149

NUCLEAR PROPERTIES AND REACTIONS, A=190-219, EXPERIMENTAL

RADIOACTIVE DECAY

4147 (BNL—21403) **Identification and decay of ^{190}W, ^{196}Os, ^{230}Ra, and ^{230}Ac.** Katcoff, S.; Gilat, J.; Haustein, P.E.; Franz, E.M.; Morcos, N.A.; Ward, T.E.; Smith, H.A. Jr.; Hill, J.C.; Petry, R.F. (Hanford Engineering Development Lab., Richland, Wash. (USA); Indiana Univ., Bloomington (USA); Oklahoma Univ., Norman (USA); Iowa State Univ. of Science and Technology, Ames (USA)). Contract E(30-1)-16. 4p. (CONF-760560—6). Dep. NTIS $3.50.

From 3. international conference on nuclides far from stability; Corsica, Italy (19 May 1976).

Several new or poorly characterized neutron-rich nuclides were produced and studied at the Brookhaven Medium Energy Intense Neutron facility, MEIN. ^{190}W decays with T/sub 1/2/ = 30.0 +- 1.5 min, E/sub beta/ = 0.93 +- 0.07 MeV, and γ's of 157.6 and 162.1 keV. ^{196}Os decays with T/sub 1/2/ = 35.0 +- 0.4 min and γ's at 126.1, 200.7, 207.0, 257.0, 315.3, 407.6, 522.2, and 628.9 keV. ^{230}Ra decays with T/sub 1/2/ = 93 +- 2 min to 122 +- 3 sec ^{230}Ac; γ-ray energies and intensities are tabulated. A decay scheme is proposed for ^{190}W, and many of the transitions following the decay of ^{230}Ac are between known levels in ^{230}Th.

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 4150

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 4145, 4146

4148 (BNL—21216) **Optical theorem for heavy-ion scattering.** Schwarzschild, A.Z.; Auerbach, E.H.; Fuller, R.C.; Kahana, S. (Argonne National Lab., Ill. (USA)). 1976. Contract E(30-1)-16. 8p. (CONF-760424—17). Dep. NTIS $3.50.

From Symposium on macroscopic features of heavy ion collisions; Argonne, Illinois, United States of America (USA) (1 Apr 1976).

An heuristic derivation is given of an equivalent of the optical theorem stated in the charged situation with the remainder or nuclear elastic scattering amplitude defined as a difference of elastic and Coulomb amplitudes. To test the detailed behavior of this elastic scattering amplitude and the cross section, calculations were performed for elastic scattering of ^{16}O + ^{58}Ni, ^{136}Xe + ^{209}Bi, ^{84}Kr + ^{208}Pb, and ^{11}B + ^{26}Mg at 63.42 to 114 MeV. (JFP)

4149 (BNL—21269) **Elastic scattering induced by ^{16}O on ^{208}Pb.** Videbaek, F.; Goldstein, R.B.; Grodzins, L.; Steadman, S.G.; Belote, T.A.; Garrett, J.D. (Hanford Engineering Development Lab., Richland, Wash. (USA)). 1976. Contract E(30-1)-16. 14p. (CONF-760424—16). Dep. NTIS $3.50.

From Symposium on macroscopic features of heavy ion collisions; Argonne, Illinois, United States of America (USA) (1 Apr 1976).

Elastic scattering cross sections were measured for ^{16}O on ^{208}Pb targets at incident energies of 80, 83, 88, 90, 96, and 102 MeV. These data along with existing elastic scattering measurements for this system at 94, 104, 129.5, 140, 192, and 216.6 MeV were analyzed in terms of the optical model. For incident energies near the Coulomb barrier, a significant difference is observed between the grazing angular momentum and the total reaction cross sections predicted from the optical model and such values obtained from the semiclassical "quarter-point" prescription. Measured quasielastic and fission cross sections exceed the "quarter-point" total reaction cross section as much as 35 percent at the lowest incident energies in this analysis, indicating that it is imperative that the "quarter-point" method not be used to predict grazing angular momenta and reaction cross sections at incident energies near the Coulomb barrier. The incidence energy dependence of the radial region in which the real nuclear potential is determined by the elastic data also has been studied.

4150 (ORNL—5137, pp 1-8) **Experimental nuclear physics: Oak Ridge Electron Linear Accelerator program.** Harvey, J.A. May 1976.

In Physics Division annual progress report for period ending December 31, 1975.

Neutron-cross-section experiments of many types were continued, and techniques and equipment for making the measurements were improved. Capture cross-section measurements were extended from the earlier low-energy cutoff of approximately 3 keV down to 100 eV to permit a measurement of the capture cross section of ^{59}Ni. The nuclides ^{203}Tl and ^{205}Tl were studied to determine the duration of stellar nucleosynthesis. Nuclides near closed shells, such as ^{32}S, ^{58}Ni, ^{60}Ni, ^{88}Sr, and ^{100}Mo, were studied. Capture γ-ray spectra measurements continued to be a powerful technique for nuclear spectroscopy. The investigation of the isotopes of tin and lead was rewarding in determining level schemes for the odd isotopes of tin and in providing information on E2 radiative strength in ^{208}Pb. A study of the capture γ rays from neutrons on ^{100}Mo showed that valence capture does not play a dominant role for this nuclide. In addition to the study of nuclides such as ^{208}Pb to determine the fragmentation of the shell-model states, total cross section measurements were made on several nuclides such as ^{23}Na, ^{233}U, ^{240}Pu, and the isotopes of nickel. An analysis of the total cross section of ^{207}Pb showed a large d-wave contribution in addition to the s-wave contribution for 1^- states. A new experiment to measure the (n,α) and (n,p) cross sections of ^{59}Ni from 0.01 eV to approximately 20 keV, using a diffused-junction silicon detector, has produced several unique results. Alpha and proton widths of many resonances were determined in the keV energy region. Measurements of ^{6}Li(n,α)T have shown that the alphas and tritons are anisotropic even in the eV energy region. A new neutron-flux monitor was developed which consists of a thin ^{6}LiF layer between two 0.1-mm sheets of NE-110 scintillator; a fast, good-resolution, α + T, 4π detector for reaction products results. The light is detected by two photomultipliers located out of the neutron beam. 1 table. (RWR)

SPONTANEOUS AND INDUCED FISSION

REFER ALSO TO CITATION(S) 4145

4151 (UCRL—78344) **Status of U-235 fission as a cross section standard.** Carlson, G.W.; Czirr, J.B. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 25 Jun 1976. Contract W-7405-Eng-48. 10p. (CONF-760647—4). Dep. NTIS $3.50.

From Meeting on fast neutron fission cross sections of U-233, U-235, U-238, and Pu-239; Argonne, Illinois, United States of America (USA) (28 Jun 1976).

A review is made of the current status of ^{235}U fission cross section data from thermal to 20 MeV neutron energies. The accuracy achieved is compared with the 1 percent accuracy required of a reaction-cross-section standard throughout this range. The energy ranges from thermal to 10 keV, 10 keV to 0.8 MeV and 0.8 to 20 MeV are considered separately because of the different experimental techniques required in each. The goal of normalizing all fission cross sections to the thermal value and the current degree of success is discussed.

NUCLEAR PROPERTIES AND REACTIONS, A=220 AND ABOVE, THEORETICAL

ENERGY LEVELS AND TRANSITIONS

4152 (TID—27131) **Study of giant resonances in nuclei by inelastic scattering.** Satchler, G.R. (Oak Ridge National Lab., Tenn. (USA)). 1976. Contract W-7405-eng-26. 145p. Dep. NTIS $6.00.

The evidence for new giant resonances, especially an isoscalar quadrupole, is reviewed and the theoretical expectations are summarized. The models used to analyze the data from inelastic scattering measurements are described and discussed. The use of sum rules is discussed critically.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 4177

SPONTANEOUS AND INDUCED FISSION

REFER ALSO TO CITATION(S) 4165

4153 **Closed-shell effects on spontaneous-fission lifetimes of transuranics in nuclear wastes.** Pai, H.L.; Andrews, D.G. (Univ. of Toronto). *Trans. Am. Nucl. Soc.*; **23**: 500(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

NUCLEAR PROPERTIES AND REACTIONS, A=220 AND ABOVE, EXPERIMENTAL

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 4157

4154 **Nuclear Data Sheets for A = 243.** Ellis, Y.A. (Oak Ridge National Lab., TN). *Nucl. Data Sheets;* **19**: No. 1, 103-141(Sep 1976).

Nuclear structure information for all nuclei with mass number A = 243 is evaluated. The results from various decay and reaction experiments are compared. Adopted data, levels, and spin and parity assignments are given.

4155 **Nuclear Data Sheets for A = 245.** Ellis, Y.A. (Oak Ridge National Lab., TN). *Nucl. Data Sheets;* **19**: No. 1, 143-179(Sep 1976).

Nuclear structure information for all nuclei with mass number A = 245 is evaluated. The results from various decay and reaction experiments are compared. Adopted data, levels, and spin and parity assignments are given.

4156 **Nuclear Data Sheets for A = 247.** Ellis, Y.A. (Oak Ridge National Lab., TN). *Nucl. Data Sheets;* **19**: No. 1, 181-202(Sep 1976).

Nuclear structure information for all nuclei with mass number A = 247 is evaluated. The results from various decay and reaction experiments are compared. Adopted data, levels, and spin and parity assignments are given.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 4147, 4170

4157 (COO—3496-56) **Studies of heavy ion reactions and transuranic nuclei. Progress report, June 1, 1975—June 1, 1976.** Huizenga, J.R. (Rochester Univ., N.Y. (USA). Dept. of Chemistry). 1976. Contract E(11-1)-3496. 174p. Dep. NTIS $6.75.

Experimental research on heavy ion reactions and transuranic nuclei is summarized. A list of publications is included. (JFP)

4158 **Resonance parameters of the 6.67-, 20.9-, and 36.8-eV levels in ^{233}U.** Olsen, D.K.; de Saussure, G.; Perez, R.B.; Difilippo, F.C. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.;* **23**: 496-498(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

4159 **Measurement of the ^{235}U(n,γ) cross section with an Fe-filtered neutron beam.** Quan, B.L.; Pendt, R.H.; Block, R.C. (Rensselaer Polytechnic Inst., Troy, NY). *Trans. Am. Nucl. Soc.;* **23**: 498-499(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

4160 **Actinide cross-section calcuations and evaluations.** Mann, F.M.; Schenter, R.E. (Hanford Engineering Development Lab., Richland, WA). *Trans. Am. Nucl. Soc.;* **23**: 546-547(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

SPONTANEOUS AND INDUCED FISSION

4161 (ANL—75-49) **Chemical Engineering Division, fast-neutron dosimetry annual report, July 1974—June 1975.** Heinrich, R.R.; Dudey, N.D.; Greenwood, L.R.; Chellew, N.R.; Popek, R.J.; Malewicki, R.L.; Cafasso, F.A.; Burris, L. (Argonne National Lab., Ill. (USA)). 1975. 43p. AT.

Separate abstracts are prepared for the three sections of this report. (CES)

4162 (ANL—75-49, pp 22-30) **Interlaboratory LMFBR Reaction Rate (ILRR) program.** Popek, R.J.; Heinrich, R.R.; Dudey, N.D. 1975.

In Chemical Engineering Division, fast-neutron dosimetry annual report, July 1974—June 1975.

The ANL effort in the ILRR program is directed toward improving methods for the measurement of absolute fission rates of ^{235}U, ^{238}U, ^{237}Np, and ^{239}Pu, and the production rates of fission products in the foils of these actinide isotopes. Thermal fission yields of ^{235}U, using the K-factor technique for an NBS thermal cavity irradiation, have been calculated on the basis of data from the NBS fission chamber. These values, in general, have an uncertainty of +-3 percent and are in good agreement with reported literature values. Fission-product reaction rates for ^{235}U, ^{238}U, ^{237}Np, and ^{239}Pu, measured in the Coupled Fast Reactivity Measurement Facility (CFRMF) and Big-10 irradiations, are presented. In addition, nonfissile reaction rates from the Big-10 irradiation are also reported. The fission rates determined by the K-factor technique in the Big-10 irradiation for six fission products exhibited good precision among the various fission products. Preliminary NBS fission rates indicate that the agreement between the methods is about +-2 percent. (auth)

4163 (BNL—21560) **Evaluation of the ^{235}U fission cross-section from 100 eV to 20 MeV.** Bhat, M.R. (Brookhaven National Lab., Upton, N.Y. (USA)). 1976. Contract E(30-1)-16. 24p. (CONF-760647—6). Dep. NTIS $3.50.

From Meeting on fast neutron fission cross sections of U-233, U-235, U-238, and Pu-239; Argonne, Illinois, United States of America (USA) (28 Jun 1976).

The evaluation of the ^{235}U fission cross section from 100 eV to 20 MeV for ENDF/B-V is described. The evaluated average cross sections from 100 eV to 200 keV are given, and it is proposed to include structure in the cross section in this energy region. Above 200 keV, the cross section is given as a smooth curve, and is recommended as a standard. Preliminary error estimates in the cross section are also given.

4164 (DP—1394) **Consistent set of heavy actinide multigroup cross sections.** Benjamin, R.W.; McCrosson, F.J.; Gorrell, T.C.; Vandervelde, V.D. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). Dec 1975. Contract AT(07-2)-1. 98p. Dep. NTIS $5.50.

A consistent set of multigroup neutron cross sections was developed for nuclides in the production chain from ^{242}Pu to ^{253}Es. Initial multigroup data sets were derived from ENDF/B and existing Savannah River evaluated data libraries; where differential data were lacking, resonance-region model calculations and measured integral cross sections were used to fabricate the energy-dependent multigroup data. The evaluated multigroup cross section data were utilized in reactor calculations to predict yields for several experimental test measurements and long-term reactor irradiations in flux spectra of varying hardness. The calculations with the JOSHUA system reproduce the reactor environment as a function of time and predict the concentrations of actinide nuclides in the chain. Multigroup cross section data were modified within the experimental uncertainties until predicted nuclide concentrations matched experimental results within reasonable limits over the range of neutron flux spectra.

4165 **Time-dependent spectra of photons and spontaneous-fission neutrons for applied problems.** Foster, D.G.; England, T.R. Jr. (Los Alamos Scientific Lab., NM). *Trans. Am. Nucl. Soc.;* **23**: 551(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

4166 **Spectra of equilibrium delayed neutrons from fast fission of ^{235}U, ^{238}U, and ^{239}Pu.** Evans, A.E.; Krick, M.S. (Los Alamos Scientific Lab., NM). *Trans. Am. Nucl. Soc.;* **23**: 491-492(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

4167 **Delayed-neutron spectra from ^{232}Th, ^{233}U, ^{235}U, ^{238}U, and ^{239}Pu.** Eccleston, G.W.; Woodruff, G.L. (Univ. of Washington, Seattle). *Trans. Am. Nucl. Soc.;* **23**: 492-493(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

4168 **^{238}U subthreshold neutron-induced fission cross section.** Difilippo, F.C.; Perez, R.B.; de Saussure, G.; Olen, D.K.; Ingle, R.W. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.;* **23**: 499-500(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

4169 **Monte Carlo analysis of the 2200 m/sec alpha values of fissile nuclides.** Beer, M.; Kalos, M.H.; Lichtenstein, H.; Steinberg, H.A.; Troubetzkoy, E.S. (MAGI, Elmsford, NY). *Trans. Am. Nucl. Soc.;* **23**: 509(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

4170 **Evaluation and production testing of cross sections for ^{244} ^{246} ^{248}Cm.** Benjamin, R.W. (E.I. duPont de Nemours and Co., Aiken, SC); McCrosson, F.J.; Gettys, W.E. *Trans. Am. Nucl. Soc.;* **23**: 545-546(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

NUCLEAR THEORY

4171 (RLO—1388-670) **Theoretical Nuclear Physics Program. Progress report, October 1, 1974—June 30, 1975.** (Washington Univ., Seattle (USA). Dept. of Physics). 1975. Contract AT(45-1)-1388. 28p. Dep. NTIS $4.00.

Research on nuclear and high energy theoretical physics is summarized. Also included are statistical mechanics and many-body physics. A list of publications is given. (JFP)

NUCLEAR STRUCTURE

4172 **Method for calculating average beta energies and beta spectral shapes.** Stamatelatos, M.G.; England, T.R. (Los Alamos Scientific Lab., NM). *Trans. Am. Nucl. Soc.;* **23**: 502-503(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

NUCLEAR MATTER

4173 (ORO—3992-267) **Finite temperature system of strongly interacting baryons.** Bowers, R.L.; Gleeson, A.M.; Pedigo, R.D.; Wheeler, J.W. (Texas Univ., Austin (USA). Center for Particle Theory). Jul 1976. Contract E(40-1)-3992. 60p. Dep. NTIS $4.50.

A fully relativistic finite temperature many body theory is constructed and used to examine the bulk properties of a system of strongly interacting baryons. The strong interactions are described by a two parameter phenomenological model fit to a simple description of nuclear matter at T = 0. The zero temperature equation of state for such a system which has already been discussed in the literature was developed to give a realistic description of nuclear matter. The model presented here is the exact finite temperature extension of that model. The effect of the inclusion of baryon pairs for T greater than or equal to $2mc^2/k$ is discussed in detail. The phase transition identified with nuclear matter vanishes for system temperatures in excess of T/sub C/ = 1.034×10^{11} °K. All values of epsilon (P,T) correspond to systems that are causal in the sense that the locally determined speed of sound never exceeds the speed of light.

4174 **Nuclear surface diffuseness.** Myers, W.D.; von Groote, H. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). *Phys. Lett., B;* **61**: No. 2, 125-128(15 Mar 1976).

The variation in nuclear surface diffuseness to be expected as one moves from light to heavy nuclei has been calculated and the value of b_0 (the diffuseness of semi-infinite nuclear matter) has been extracted from measured values of the diffuseness of the proton distribution.

4175 **The nuclear surface studied with a momentum-dependent interaction in the Thomas-Fermi and Hartree approximations.** Randrup, J. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). *Nucl. Phys., A;* **259**: No. 2, 253-271(15 Mar 1976).

A self-consistent many-particle model containing a two-body interaction with a quadratic momentum dependence is developed in the Hartree approximation. The various possible algebraic forms of the momentum dependence are studied in parallel. A simple modification of the standard Thomas-Fermi approximation is formulated for the treatment of models with momentum-dependent interactions. Numerical calculations are carried out for symmetric semi-finite nuclear matter. The modified Thomas-Fermi approximations, as compared with the Hartree approximation, is found to underestimate the surface diffuseness and the surface energy by typically 10%. It is demonstrated that the surface properties are very sensitive to the particular algebraic form of the quadratic momentum dependence.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 4180

4176 (BNL—21217) **Systematics of quasi-elastic processes induced by heavy ions.** Baltz, A.J. (Brookhaven National Lab., Upton, N.Y. (USA)). Contract E(30-1)-16. 29p. (CONF-760424—19). Dep. NTIS $4.00.

From Symposium on macroscopic features of heavy ion collisions; Argonne, Illinois, United States of America (USA) (1 Apr 1976).

The discussion of the systematics of quasi-elastic processes induced by heavy ions includes transfer angular distribution data and theory, some successes and failures of the DWBA and coupled channels theories in describing heavy ion reaction data, and a quasi-elastic process induced by a heavier projectile, $^{232}Th(^{40}Ar,K)$, and implications for deep inelastic reactions with even heavier projectiles such as Kr and Xe. An attempt is made to delineate areas that are well described theoretically from the specific features that seem not to be understood. (JFP)

4177 (ORNL—5137, pp 133-152) **Theoretical physics.** Satchler, G.R. May 1976.

In Physics Division annual progress report for period ending December 31, 1975.

Nuclear theory efforts were dominated by heavy-ion physics. Advances were made in developing theoretical and computational tools for handling the complex problems posed by the collision of two nuclei. These should shed light on the more general problem of large-amplitude collective motions of a quantal fluid. At one level (the "macroscopic" one), the collision is regarded as a problem in fluid dynamics, the collision of two fluid drops. At another level (the "microscopic" one), the process is considered in terms of the motions of the individual nucleons and their forces; time-dependent Hartree-Fock theory is the tool here. At the same time, theoretical links are being forged between the microscopic and macroscopic levels. In the high-energy limit, where the individual nucleon motions are all-important, a classical approximation is also being studied, rather like the collision of two clusters of billiard balls. Work continues on more conventional nuclear reaction and structure models also. 14 figures, 2 tables. (RWR)

4178 (LA-tr—76-19) **Radochemical investigations.** Denisov, F.P.; Mekhedov, V.N. 1972. Translation of Chapter 6 from Yaderne Reaktsii pri Vysokikh Energiiakh, 1972, Atomizdat Press, Moscow. 55p. Dep. NTIS $4.50.

The consideration of radiochemical investigations covers a general discussion of this method of investigation of nuclear reactions and the theory as applied to reactions with escape of a small number of nucleons, spallation reactions, the spallation of medium and heavy elements, the formation of radioactive fragments, secondary reactions, and recoil nuclei. A bibliography listing 156 items is included. (JFP)

4179 **New statistical-preequilibrium nuclear model code.** Arthur, E.D.; Young P.G. (Los Alamos Scientific Lab., NM). *Trans. Am. Nucl. Soc.;* **23**: 500-501(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

NUCLEAR MODELS

4180 **A schematic model for the investigation of nuclear reactions.** Coelho, H.T. (Pernambuco Univ., Recife (Brazil). Instituto de Fisica); Dreizler, R.M.; Berger, W. (Frankfurt Univ. (F.R. Germany). Inst. fuer Theoretische Physik); Galbraith, H.W. (Los Alamos Scientific Lab., N.Mex. (USA)). *Nucl. Phys., A;* **259**: No. 2, 231-245(15 Mar 1976).

An extension of the schematic model of Lipkin, Glick and Meshkov to include reaction modes with one particle in the continuum is introduced. The model set up is amenable to the investigation of various approximations necessary in a realistic shell model in the continuum calculations. The first application centering on the use of truncated bound state shell-model spaces is given.

RADIATION AND SHIELDING PHYSICS

RADIATION PHYSICS

REFER ALSO TO CITATION(S) 3793, 4204, 4212, 4220

4181 (BNWL-SA—5828) **Fundamentals of x-ray dosimetry.** Roesch, W.C. (Hanford Engineering Development Lab., Richland, Wash. (USA)). 5 May 1976. Contract E(45-1)-1830. 20p. (CONF-760717—1). Dep. NTIS $3.50.

From American Association of Physicists in medicine dosimetry summer school; Burlington, Vermont, United States of America (USA) (19 Jul 1976).

Fundamental information about x-ray dosimetry is presented. Definitions are given and expanded on for dose, absorbed dose including microdosimetry, radiation physics (properties of the radiation that are important to dosimetry), and dosimetry (how the properties are dealt with in determining dose). 5 figs, 12 refs. (GHT)

4182 (UCRL—77839) **Experimental x-ray mass attenuation coefficients between the M_I and M/sub V/ absorption edge of rhenium.** Steele, W.J.; Johnson, J.M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 19 Feb 1976. Contract W-7405-ENG-48. 9p. (CONF-760803—4). Dep. NTIS $3.50.

From 34. Electron Microscopy Society of America annual meeting; Miami Beach, Florida, United States of America (USA) (9 Aug 1976).

Experimental values obtained for x-ray mass attenuation coefficients between the M/sub I/ and M/sub V/ absorption edges of rhenium are presented below. Also presented is a brief discussion of the experimental procedure.

4183 **Report on the fourth conference on transport theory.** Kaper, H.G. (Argonne National Lab., IL); Zweifel, P.F. *Transp. Theory Stat. Phys.*; **4**: No. 3, 105-123(1975).

From 4. conference on transport theory; Blacksburg, VI, USA (10 Mar 1975).

A summary of the conference is given, including the conference program and highlights of the technical sessions. Topics in the technical sessions include: discussion of the mono-energetic transport equation with isotropic scattering in two-dimensional geometry; the slab transport equation; the spectrum of the transport operator for time-dependent slowing down problems; the resolvent integration method to the multigroup transport operator; the multigroup transport operator with anisotropic scattering; asymptotic methods applied to the transport equation; the Hilbert space approach to the transport operator in multiplying media; the criticality problem for a reflected slab in a two-group approximation, using the original singular eigenfunction method; the critical slab multigroup transport problem; a new symmetry group for the neutron transport equation; the extension of the transfer matrix method to treat transport problems in spherical geometry; a three-dimensional problem with continuous energy dependence and isotropic scattering; a space-time stability analysis of a nuclear reactor with nonlinear feedback effects; derivation of diffusion-type equations for the "self" Green's function of a particle in a liquid; the linearized Boltzmann equation of rarified gas dynamics with the linear BGK model of molecular interaction; the motion of a sphere through a fluid; kinetic theory; error analysis of coarse network calculations with transport computer codes; and diffusion of binary gas mixtures. (GHT)

4184 **Energy loss and ranges of charged particles in matter.** Sigmund, P. (Orsted Inst., Copenhagen). pp 278-286 of In Radiation research. Biomedical, chemical, and physical perspectives. Nygaard, O.F. (ed.). New York; Academic Press, Inc. (1975).

From 5. international radiation research congress meeting; Seattle, Washington, USA (14 Jul 1974).

See CONF-740715—.

A review of research into penetration phenomena such as charged-particle channeling, light-ion stopping, heavy-ion stopping, ion beams used for surface analysis, and particle range calculations is presented. 64 refs (GHT)

4185 **Channeling: a tool for the study of the interactions of energetic particles penetrating solids.** Datz, S. (Oak Ridge National Lab., TN). pp 287-301 of In Radiation research. Biomedical, chemical, and physical perspectives. Nygaard, O.F. (ed.). New York; Academic Press, Inc. (1975).

From 5. international radiation research congress meeting; Seattle, Washington, USA (14 Jul 1974).

See CONF-740715—.

The concept of channeling is described, and its application to the determination of interatomic potentials and stopping powers, and to the definition of atomic states of fast ions penetrating solids is shown. Atomic interactions from planar channeling measurements, hyperchanneling, and charge exchange of channeled ions are discussed. 14 figs, 1 table, 9 refs (GHT)

4186 **Transmission of fast molecules through solids.** Remillieux, J. (Universite Claude Bernard, Lyon). pp 302-314 of In Radiation research. Biomedical, chemical, and physical perspectives. Nygaard, O.F. (ed.). New York; Academic Press, Inc. (1975).

From 5. international radiation research congress meeting; Seattle, Washington, USA (14 Jul 1974).

See CONF-740715—.

A review of the anomalies observed with molecular beams in stopping power, angle and energy distributions inside and beyond the foil, channeling properties, charge-exchange processes, and beam-foil excitation is presented for MeV beams of H^+, H_2^+ and H_3^+ ions. 9 figs, 17 refs (GHT)

4187 **Primary processes and track effects in irradiated media.** Ritchie, R.H.; Brandt, W. (Oak Ridge National Lab., TN). pp 315-324 of In Radiation research. Biomedical, chemical, and physical perspectives. Nygaard, O.F. (ed.). New York; Academic Press, Inc. (1975).

From 5. international radiation research congress meeting; Seattle, Washington, USA (14 Jul 1974).

See CONF-740715—.

When heavy charged particles penetrate condensed matter at velocities large compared to the Bohr velocity, energy is deposited in different modes throughout two spatially distinct domains which are referred to as the infratrack and ultratrack. The role of the infratrack in primary radiation processes is discussed. 8 figs, 11 refs (GHT)

4188 **Reflection of charged-particle beams at near-grazing incidence.** Spencer, L.V.; Eisenhauer, C. (National Bureau of Standards, Washington, DC). *Trans. Am. Nucl. Soc.*; **23**: 609-610(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

SHIELDING CALCULATIONS AND EXPERIMENTS

REFER ALSO TO CITATION(S) 2966, 2967, 2968, 2969, 2970, 2971, 2974, 2976, 3763, 4208

4189 (ERDA-tr—125) **Questions on the physics of reactor shielding. Volume 6.** Egorov, Yu.A.; Mashkovich, V.P.; Pankrat'ev, Yu.V.; Suvorov, Ya.P.; Tsypin, S.G. 1974. Translation of Voprosy fiziki zashchity reaktorov, vypusk 6, Atomizdat, Moscow, 1974. 296p. Dep. NTIS $9.25.

Separate abstracts are included for each of the 31 papers included.

4190 (ERDA-tr—125, pp 46-53) **Applying methods from photometry and the theory of radiant heat exchange to the transfer of ionizing radiation.** Mironov, V.N. 1974. Translated from pp 37-43 of Voprosy fiziki zashchity reaktorov, vypusk 6, Atomizdat, Moscow, 1974.

In Questions on the physics of reactor shielding. Volume 6.

The possibility of applying the basic propositions of photometry and the theory of radiant heat transfer to the transport of gamma radiation through heterogeneous biological shielding is demonstrated.

4191 (ERDA-tr—125, pp 54-72) **Using perturbation theory for problems concerning scattered gamma radiation.** Petrov, E.E.; Shemetenko, B.P. 1974. Translated from pp 43-59 of Voprosy fiziki zashchity reaktorov, vypusk 6, Atomizdat, Moscow, 1974.

In Questions on the physics of reactor shielding. Volume 6.

The application of the theory of small perturbations to gamma radiation is illustrated. The method makes it possible to account for the accumulation of the scattered radiation and to consider not only the scattering, but also the absorbing properties of the scattering media.

4192 (ERDA-tr—125, pp 92-99) **Investigating the field of scattered radiation at great distances from the source.** Zolotukhin, V.G.; Ksenofontov, A.I.; Panchenko, A.M.; Sinev, V.N. 1974. Translated from pp 72-78 of Voprosy fiziki zashchity reaktorov, vypusk 6, Atomizdat, Moscow, 1974.

In Questions on the physics of reactor shielding. Volume 6.

A nonanalog method of modeling the radiation transfer process is described which uses Boltzmann equations and the dispersion minimization method. Sample calculations for 2 MeV gamma quanta in iron are presented.

4193 (ERDA-tr—125, pp 100-105) **Passage of gamma-radiation from point sources with an arbitrary angular distribution of quanta through curved ducts in shielding.** Zolotukhin, V.G.; Efimenko, B.A.; Klimanov, V.A.; Kochanov, V.A.; Mashkovich, V.P.; Orlov, N.Yu. 1974. Translated from pp 78-82 of Voprosy fiziki zashchity reaktorov, vypusk 6, Atomizdat, Moscow, 1974.

In Questions on the physics of reactor shielding. Volume 6.

The question of the formation of gamma radiation fields in curved ducts of shielding is examined. The Monte Carlo method is used for the solution of the problem.

4194 (ERDA-tr—125, pp 140-144) **Capture gamma-radiation yield from a layer of iron for neutrons striking at an angle.** Degtyarev, S.F.; Repin, N.N.; Sakovich, V.A.; Sakharov, V.M.; Suvorov, A.P.; Tarasov, V.V. 1974. Translated from pp 108-110 of Voprosy fiziki zashchity reaktorov, vypusk 6, Atomizdat, Moscow, 1974.

In Questions on the physics of reactor shielding. Volume 6.

Experimental and theoretical studies on the angular distributions of capture γ radiation beyond a layer of iron for neutron incidence angles of 0^0, 45^0, and 60^0 are reported.

4195 (ERDA-tr—125, pp 145-151) **Investigation of the field of capture gamma-radiation in solid shielding.** Bolyatko, V.V.; Gorbatov, V.S.; Reytblat, V.L.; Tkachenko, V.V.; Khokhlov, V.F.; Tsypin, S.G. 1974. Translated from pp 111-116 of Voprosy fiziki zashchity reaktorov, vypusk 6, Atomizdat, Moscow, 1974.

In Questions on the physics of reactor shielding. Volume 6.

The spatial-energy distributions of capture γ-rays in solid shielding was investigated and the contribution of the capture γ radiation to the total γ radiation and neutron dose rate in the medium was evaluated.

4196 (ERDA-tr—125, pp 152-156) **Differential characteristics of the energy albedo of gamma-quanta for organic mediums.** Viktorov, A.A.; Mashkovich, V.P. 1974. Translated from pp 116-120 of Voprosy fiziki zashchity reaktorov, vypusk 6, Atomizdat, Moscow, 1974.

In Questions on the physics of reactor shielding. Volume 6.

Studies of the dependence of the differential characteristics of the energy albedo of γ quanta from a plane unidirectional source on the thickness of homogeneous barriers and on the radius of infinitely long cylinders are described. Results are presented for water, aluminum, iron, and lead.

4197 (ERDA-tr—125, pp 157-168) **Investigation of the field of neutrons reflected from screens with various thicknesses.** Egorov, Yu.A.; Zharkov, V.P.; Orlov, Yu.V. 1974. Translated from pp 120-129 of Voprosy fiziki zashchity reaktorov, vypusk 6, Atomizdat, Moscow, 1974.

In Questions on the physics of reactor shielding. Volume 6.

A study of the dependence of albedo characteristics on neutron incident angle and screen thickness for neutrons reflected from screens of various thicknesses is reported. Screen materials included polyethylene, titanium hydride, lithium hydride, graphite titanium, lead, and aluminum.

4198 (ERDA-tr—125, pp 169-175) **Investigation of radiative heat generation in structural materials of shielding placed in light mediums.** Avaev, V.N.; Efimov, E.P. 1974. Translated from pp 130-134 of Voprosy fiziki zashchity reaktorov, vypusk 6, Atomizdat, Moscow, 1974.

In Questions on the physics of reactor shielding. Volume 6.

Measurements and Monte Carlo calculations were performed for the gamma heat generation in cylindrical lead and steel (iron) rings in polyethylene and water shielding.

4199 (ERDA-tr—125, pp 207-216) **Analysis of complete neutron-matter interaction cross sections in nuclear reactor.** Egorov, Yu.A.; Pankrat'ev, Yu.V.; Tolstykh, V.D. 1974. Translated from pp 158-165 of Voprosy fiziki zashchity reaktorov, vypusk 6, Atomizdat, Moscow, 1974.

In Questions on the physics of reactor shielding. Volume 6.

The magnitudes and energy dependence of the interaction cross sections of neutrons in thick specimens using a narrow reactor neutron beam and a spectrometer. Some results for neutron transmission in concrete and titanium specimens are presented.

4200 (ERDA-tr—125, pp 225-230) **Matrix method of analyzing spectra of neutrons measured with He^3-spectrometer in shield materials.** Egorov, Yu.A.; Zharkov, V.P.; Orlov, Yu.V. 1974. Translated from pp 172-175 of Voprosy fiziki zashchity reaktorov, vypusk 6, Atomizdat, Moscow, 1974.

In Questions on the physics of reactor shielding. Volume 6.

The matrix method for converting instrument distributions to energy spectra for neutron spectra measured with ^{3}He spectrometers is described.

4201 (ERDA-tr—125, pp 273-290) **Analysis of the shielding properties of various concretes.** Veselkin, A.P.; Voskresenskii, E.V.; Egorov, Yu.A.; Pankrat'ev, Yu.V.; Piskunov, V.I.; Staurin, N.V. 1974. Translated from pp 207-221 of Voprosy fiziki zashchity reaktorov, vypusk 6, Atomizdat, Moscow, 1974.

In Questions on the physics of reactor shielding. Volume 6.

The shielding properties of 15 types of concretes were studied under standardized conditions in a WWR type reactor.

NEUTRON INTERACTIONS WITH MATTER

REFER ALSO TO CITATION(S) 2477, 2983, 2988, 3765, 4183, 4220

4202 **k/sub infinity/ and other criticality conditions for an infinite system.** Bowden, R.L. (Virginia Polytechnic Inst. and State Univ., Blacksburg). *Transp. Theory Stat. Phys.*; **4**: No. 1, 25-36(1975).

It is shown that a study of a certain class of matrices leads to criticality conditions based on the multigroup neutron transport model for a homogeneous infinite system. A consistent definition of k/sub infinity/ is formulated. A simple example is presented.

4203 **Comparison of measurements and calculations for ORNL integral neutron scattering experiment for iron.** Cramer, S.N.; Oblow, E.M. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.*; **23**: 606-607(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

4204 **Bounded estimation of flux-at-a-point near region boundaries.** Steinberg, H. (MAGI, Elmsford, NY). *Trans. Am. Nucl. Soc.*; **23**: 607-608(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

4205 **Calculation of the response to neutrons for a detector moving in the atmosphere.** Olson, R.J.; Carter, L.L. (Los Alamos Scientific Lab., NM). *Trans. Am. Nucl. Soc.*; **23**: 608(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

4206 **Calculated and measured angular fast-neutron penetration spectra for slabs.** Miller, W.H.; Meyer, W.; Timmons, D.H. (Univ. of Missouri, Columbia). *Trans. Am. Nucl. Soc.*; **23**: 614-615(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

4207 **Spectral gamma-ray production cross sections for silicon and copper.** Rogers, V.C. (IRT Corp., San Diego, CA); Sandquist, G.M.; Dixon, D.R.; Costello, D. *Trans. Am. Nucl. Soc.*; **23**: 615-616(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

4208 **Neutron multigroup cross sections for radiotherapy shielding applications.** Wilson, W.B. (Texas A and M Univ., College Station); Smathers, J.B.; Harris, D.R.; Foster, D.G. Jr.; MacFarlane, R.E. *Trans. Am. Nucl. Soc.*; **23**: 633-634(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

MEDICAL PHYSICS

RADIATION PROTECTION STANDARDS

REFER ALSO TO CITATION(S) 3982

4209 **Dosimetric parameters and terminology relevant to radiobiology.** Oliver, R. (London Univ.). pp 547-556 of In Radiation research. Biomedical, chemical, and physical perspectives. Nygaard, O.F. (ed.). New York; Academic Press, Inc. (1975).

From 5. international radiation research congress meeting; Seattle, Washington, USA (14 Jul 1974).

See CONF-740715—.

The problems considered and the proposals made for early consideration for the revision of the ICRU Publication 10e on Radiological Dosimetry (NBS Handbook 88, 1963) are reviewed. 3 tables, 5 refs (GHT)

RADIATION SOURCE CALIBRATION AND STANDARDIZATION

REFER ALSO TO CITATION(S) 3995

DOSIMETRY

REFER ALSO TO CITATION(S) 3759, 4161, 4181

4210 **International intercomparison of neutron dosimetry.** Caswell, R.S. (National Bureau of Standards, Washington, DC); Goodman, L.J.; Colvett, R.D. pp 532-546 of In Radiation research. Biomedical, chemical, and physical perspectives. Nygaard, O.F. (ed.). New York; Academic Press, Inc. (1975).

From 5. international radiation research congress meeting; Seattle, Washington, USA (14 Jul 1974).

See CONF-740715—.

The experimental arrangements and some preliminary results of the ICRU intercomparison of neutron kerma and absorbed dose measurements are discussed. The intercomparison took place at the Radiological Research Facility of Brookhaven

National Laboratory in 1973. Some tentative conclusions are drawn. 14 figs, 1 table, 3 refs (GHT)

4211 Microdosimetery of Auger electrons. Feige, Y.; Gavron, A. (Soreq Nuclear Research Centre, Yavne, Israel). pp 557-569 of In Radiation research. Biomedical, chemical, and physical perspectives. Nygaard, O.F. (ed.). New York; Academic Press, Inc. (1975).

From 5. international radiation research congress meeting; Seattle, Washington, USA (14 Jul 1974).

See CONF-740715—.

A review is given covering the physical parameters involved in dosimetry of Auger electrons from radioisotopes that decay by electron capture. The biological significance of the findings is evaluated and compared with the results obtained in various experiments where ^{125}I was incorporated in the thyroid gland of mice and rats as well as in DNA molecules. 5 figs, 3 tables, 71 refs (GHT)

4212 Measurement of energy deposition of protons in microscopic sites. Bull, S.R. (Univ. of Missouri, Columbia); Smith, L.A.; Herbaut, Y. *Trans. Am. Nucl. Soc.*; **23**: 631-633(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

SOLID STATE PHYSICS

REFER ALSO TO CITATION(S) 3488, 3532, 4051

4213 (CONF-760421—7) **Movement of dislocations through a random array of weak obstacles of finite width.** Labusch, R.; Schwarz, R.B. (Argonne National Lab., Ill. (USA)). 1976. Contract W-31-109-Eng-38. 10p. Dep. NTIS $3.50.

From Conference on computer simulation for materials applications; Gaithersburg, Maryland, United States of America (USA) (19 Apr 1976).

The movement of a dislocation through a random array of weak obstacles of finite width has been simulated with the aid of a digital computer. Through a normalization of the equation of motion it is shown that in the absence of inertial effects the flow stress is a function of a single parameter eta$_0$ = (y$_0$/l/sub s/)$\sqrt{}$(2 GAMMA/F/sub y/), where y$_0$ is the range of the dislocation-obstacle interaction force in the direction perpendicular to the dislocation, l/sub s/ is the average distance between obstacles, F/sub y/ is the strength of the interaction force, and GAMMA is the dislocation line tension. The calculations suggest a relation of the form sigma = A (1 + eta$_0$B)/sup $^1/_3$/ for the flow stress, where A and B are constants.

4214 (RLO—2041-137) **Universality, twisted fans, and the Ising model.** Dash, J.W.; Harrington, S.J. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.; Oregon Univ., Eugene (USA). Inst. of Theoretical Science; Washington Univ., Seattle (USA). Dept. of Physics). 24 Jun 1975. Contract E(45-1)-2230. 13p. (LBL—3885). Dep. NTIS $3.50.

Critical exponents are evaluated for the Ising model using universality in the form of "twisted fans" previously introduced in Reggeon field theory. The universality is with respect to scales induced through renormalization. Exact twists are obtained at $\beta = 0$ in one loop for D = 2,3 with $\nu = 0.75$ and 0.60 respectively. In two loops one obtains ν approximately 1.32 and 0.68. No twists are obtained for eta, however. The results for the standard two loop calculations are also presented as functions of a scale.

4215 Raman studies of the semiconductor to metal transition in Ge(As). Doehler, J.; Colwell, P.J.; Solin, S.A. (Univ. of Chicago). pp 478-485 of In Physics of semiconductors. Pilkuhn, M.H. (ed.). Stuttgart; B. G. Teubner (1974).

From 12. international conference on the physics of semiconductors; Stuttgart, F.R. Germany (15 Jul 1974).

See CONF-740722—.

Using a YAG laser operating at 2.1 μm, polarized Raman spectra of Ge(As) have been measured as a function of impurity concentration. The impurity concentration ranged from 6.3 x 10^{15} cm^{-3} (semiconducting regime) to 5.5 x 10^{17} cm^{-3} (metallic regime). By fitting the lineshape of the valley-orbit Raman line, which changes markedly at the transition, semiconducting regions and metallic regions are shown to coexist. The scattering mechanism for single particle excitations in the metallic regime has been identified as intervalley fluctuations. (auth)

4216 Pressure derivatives of Fermi-surface cross sections by the solid-He phase-shift method. Schirber, J.E.; White, R.L. (Sandia Labs., Albuquerque, NM). *J. Low Temp. Phys.*; **23**: No. 3/4, 445-448(May 1976).

A technique is described for determination of the pressure derivatives of Fermi-surface cross sections which is particularly useful for small or slowly varying sheets. Solid He pressure generation is used to shift the position of a particular de Haas-van Alphen oscillation thus yielding a direct measure of the derivative.

4217 Quasispin model of itinerant magnetism. Liu, S.H. (Univ. of California, Berkeley). *Phys. Rev., B;* **13**: No. 9, 3962-3971(1 May 1976).

The problem of spin waves in itinerant ferromagnets and antiferromagnets is discussed from the band-theory point of view. In the ground state, the energy bands are spin split and there is a spin-density cloud around each ion site. When a spin wave is excited, we postulate that the spin cloud of each ion precesses as a rigid unit, i.e., a quasispin. This gives rise to a modulation of the effective exchange potential, and the difference between the modulated potential and the ground-state exchange potential has the form of the s-d interaction. Here the s part includes all the conduction electrons and the d part arises from the precession of the quasispins. The magnon energy, electron band splitting, and the magnon-magnon interaction are discussed. In every case the agreement between the result and the experiment is as good as or better than the existing theories.

SOLID STATE PLASMA

4218 Theta-pinch experiments in InSb. Bruhns, H.; Huebner, K.; Schneider, W. (Univ., Heidelberg). pp 264-268 of In Physics of semiconductors. Pilkuhn, M.H. (ed.). Stuttgart; B. G. Teubner (1974).

From 12. international conference on the physics of semiconductors; Stuttgart, F.R. Germany (15 Jul 1974).

See CONF-740722—.

In a theta-pinch device compression and expansion of the electron-hole plasma are caused by the Lorentz-force without the need of contacts at the sample. We have realized a theta-pinch in extrinsic and intrinsic InSb. For intrinsic InSb numerical calculations were performed in order to support the interpretation of the experimental results. (auth)

4219 Investigation of magnetoplasmon-phonon type surface polaritons on n-InSb. Hartstein, A. (Univ. of Pennsylvania, Philadelphia); Burstein, E.; Palik, E.D.; Kaplan, R.; Gammon, R.W.; Henvis, B.W. pp 541-555 of In Physics of semiconductors. Pilkuhn, M.H. (ed.). Stuttgart; B. G. Teubner (1974).

From 12. international conference on the physics of semiconductors; Stuttgart, F.R. Germany (15 Jul 1974).

See CONF-740722—.

The coupled magnetoplasmon-phonon type surface polaritons at n-InSb/air interfaces are studied optically using the ATR method in the configuration with a magnetic field oriented perpendicular to the sagittal plane. These data are in good agreement with theory showing non-reciprocal behavior and virtual excitation modes. Differences between theory and experiment are attributed to the effect of surface damage on the free carrier plasma. (auth)

ACOUSTIC, ELECTRIC, MAGNETIC, OPTICAL, AND THERMAL PHENOMENA

REFER ALSO TO CITATION(S) 3454, 3455, 3464, 3487, 3496, 3497, 3498, 3499, 3536, 3552

THEORETICAL PHYSICS

4220 Collection of problems in transport theory. Kaper, H.G. (Argonne National Lab., IL). *Transp. Theory Stat. Phys.*; **4**: No. 3, 125-134(1975).

Problems presented are: (1) definition of transport operators; (2) relation between the integro-differential and integral form of the transport equation; (3) asymptotic behavior of the scalar density near curved boundaries and interfaces; (4) singularities at a corner; (5) regularity of the solution of the transport equation; (7) transport equations on a manifold; (8) numerical analysis; (9) cubature; (10) point spectrum of the transport operator; (11) convergence of the multigroup approximation; (12) convergence of discrete ordinates approximations; (13) the finite double-norm property; (14) convergence of discrete ordinates approximation. The presentation of the problems is intended to direct attention to gaps in the existing knowledge of transport theory and to stimulate research into new areas of transport theory. (GHT)

GENERAL AND MISCELLANEOUS

4221 Coupled photon/electron calculation of dose enhancement in thin regions. Dresser, M.M.; Gordon, J.D. (TRW Defense and Space Systems Group, Redondo Beach, CA). *Trans. Am. Nucl. Soc.;* **23**: 608-609(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

RELATIVITY AND GRAVITATION

REFER ALSO TO CITATION(S) 4035

OPTICS

4222 (UCRL-Trans—11122) **Accuracy of the solution of the transfer equation for a plane layer of high optical thickness with strongly anisotropic scattering.** Konovalov, N.V. (AN SSSR, Moscow. Inst. Prikladnoj Matematiki). 1975. Translation of USSR Preprint No. 94. 23p. Dep. NTIS $4.00.

The accuracy of the calculation of the characteristics of a radiation field in a plane layer is investigated by solving the transfer equation in dependence on the error in the specification of the scattering indicatrix. It is shown that a small error in the specification of the indicatrix can lead to a large error in the solution at large optical depths. An estimate is given for the region of optical thicknesses for which the emission field can be determined with sufficient degree of accuracy from the transfer equation with a known error in the specification of the indicatrix. For an estimation of the error involved in various numerical methods, and also for a determination of the region of their applicability, the results of calculations of problems with strongly anisotropic indicatrix are given.

ELECTRICITY AND MAGNETISM

4223 Charged-particle motion in a dipole magnetic field. Glikman, L.G. *Sov. Phys. - Tech. Phys. (Engl. Transl.);* **19**: No. 4, 435-440(Oct 1974).

Simple relations are found which characterize the features of charged-particle motion in the field of a magnetic dipole. In particular, the conditions necessary for penetration of a particle to the center of the magnetic dipole are refined, and conditions are determined which are sufficient for a magnetic dipole to act as a mirror that reflects incident particles.

4224 Unsteady-state effects in limiting current measurements. Selman, J.R.; Tobias, C.W. (Univ. of California, Berkeley). *J. Electroanal. Chem.;* **65**: 67-85(1975).

In the measurement of limiting currents, unless the approach to the mass transfer limiting conditions by a current ramp or by potential scan is sufficiently slow, the apparent limiting currents obtained are higher than those corresponding to steady state transport. A review of experimental results on limiting currents in free convection at horizontal electrodes indicates that steady state transport may be achieved nearly three times faster by potential scan than by a current ramp. Examination of limiting current data obtained on a rotating disk reveals that this is also the case in laminar forced convection. An unsteady-state diffusion model allows the prediction of the maximum current obtained in fast potential scanning. Criteria are established for estimating the time required for reaching steady-state transport conditions when a current ramp or potential scan is used for the approach to limiting current. (auth)

MATHEMATICAL PHYSICS

REFER ALSO TO CITATION(S) 4171

CONTROLLED THERMONUCLEAR RESEARCH

4225 Technology index for plasmaphysics research and fusion reactors. Volume 10, No. 6, 1976. Bibliography, author index, subject index, appendix. Leopoldshafen, Ger.; Zentralstelle fuer Atomkernenergie-Dokumentation (1976). vp.

4226 Technology index for plasmaphysics research and fusion reactors. Volume 10, No. 5, 1976. Bibliography, author index, subject index, appendix. Leopoldshafen, Ger.; Zentralstelle fuer Atomkernenergie-Dokumentation (1976). 50p.

4227 Plasma physics index. Volume 11, No. 6, 1976. Bibliography, author index, subject index. Leopoldshafen, Ger.; Zentralstelle fuer Atomkernenergie-Dokumentation (1976). 175p.

PLASMA RESEARCH

REFER ALSO TO CITATION(S) 2683, 3681

PLASMA CONFINEMENT AND HEATING

REFER ALSO TO CITATION(S) 4238

4228 (MATT—1262) **Calculations of TFTR neutral beam injection.** Post, D.E.; Rutherford, P.H.; Furth, H.P.; Smith, R.R. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Jul 1976. Contract E(11-1)-3073. 33p. Dep. NTIS $4.00.

A set of numerical calculations using a one-dimensional tokamak transport code have been done to provide estimates of the operating parameters of TFTR. The calculations have included a time-dependent self-consistent treatment of neutral beam deposition, plasma heating, and beam reactions. The effects of impurity radiation and impurity enhancement of the ion impact ionization cross section were studied. These effects were found to limit the useful injection pulse length to roughly one energy confinement time.

4229 Laser-heating of a conoidal plasma in a magnetic field. Hwang, H.K.; Chan, P.W.; Wright, D.L. (Colorado State Univ., Fort Collins (USA). Dept. of Electrical Engineering). *Phys. Lett., A;* **56**: No. 2, 109-111(8 Mar 1976).

A self-similar plasma model is used to investigate the heating and the confinement of laser-produced plasmas in a strong magnetic field. Using the Runge-Kutta method, numerical values of plasma temperature, displacement, absorption and velocity as a function of time are obtained for a wide range of experimental conditions using a high power pulsed CO_2 laser incident on a solid target.

4230 Fueling, heating, and leaking of plasma in mirror reactors. Moir, R.W.; Carlson, G.A. (Univ. of California, Livermore). *Trans. Am. Nucl. Soc.;* **23**: 39-40(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

4231 Ripple-assisted penetration of neutral-beam-injected ions into tokamak plasmas. Jassby, D.L.; Goldston, R.J.; Sheffield, G.V. (Princeton Univ., NJ). *Trans. Am. Nucl. Soc.;* **23**: 40-41(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

4232 Neoclassical ion confinement in a elliptic tokamak reactor. Tsang, K.T.; Uckan, N.A.; Callen, J.D. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.;* **23**: 42-44(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

4233 Plasma engineering and thermonuclear burn dynamics of a fusion reactor based on reverse-field Z-pinch confinement. Hagenson, R.L. (Los Alamos Scientific Lab., NM); Krakowski, R.A.; Martin, J.G. *Trans. Am. Nucl. Soc.;* **23**: 50-51(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

PLASMA DIAGNOSTICS

REFER ALSO TO CITATION(S) 3770

4234 (EUR-CEA-FC—773) **Study of a filter spectrometer in the framework of a new method for measuring the temperature of thermonuclear plasmas by relativistic Thomson scattering.** Lasalle, J. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Groupe de Recherches sur la Fusion Controlee; CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee). Jun 1975. 62p. (In French). INIS.

A new method which greatly simplifies the number of measurements necessary for obtaining the temperature in thermonuclear plasmas, using the relativistic effects of Thomson scattering is presented. A few orders of magnitude are computed for probing the feasibility of such temperature measurements. The data used correspond to magnitudes relating to T.F.R. The characteristics of a filter equipped spectrometer are then defined in view of a double function: separation of the lambda>lambda laser and lambda<lambda laser spectral lines, and rejection of the parasitic residual light at 6943 A (ruby laser) scattered from the walls of the vacuum chamber. The method is envisaged for measuring J.E.T. temperatures.

4235 (UCRL—77076) **Computerized data management: the key to laser plasma interaction data analysis.** Pettipiece, K.J.; Eddleman, H.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 13 Oct 1975. Contract W-7405-eng-48. 14p. (CONF-751130—35). Dep. NTIS $3.50.

From APS meeting; St. Petersburg, Florida, USA (10 Nov 1975).

Data processing for the laser systems in operation at LLL is discussed. Methods for automatic storage, reduction and display using the computers and the Octopus system at LLL are described. This paper briefly describes how this data is compiled, correlated, and displayed. (MOW)

4236 **Mass spectrometer.** Oron, M.; Paiss, Y. (to Rochester Univ., N.Y. (USA)). French Patent 2246060/A/. 28 Jun 1974. 18p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France); priority claim: 28 Sep 1973, USA.

The mass spectrometer according to the invention is characterized by a structure comprising an enclosure and plates defining a zone for the deflection of charged particles towards collecting members, a generator adapted to generate an electric or magnetic field in said zone for compelling the charged particles to follow paths so that they are collected through an inlet whatever their initial velocities, the positions of the points of impact being related only to the charge/mass ratio of the particles. A mass spectrometer according to the invention is suitable e.g., for determining the distribution of charges, masses and energis, as well as the elements constituting a substance converted into a plasma by a laser pulse.

4237 **Electric probes in stationary and flowing plasmas. Theory and application.** Chung, P.M. (Chicago Univ., Ill. (USA)); Talbot, L. (California Univ., Berkeley (USA)); Touryan, K.J. (Sandia Labs., Albuquerque, N.Mex. (USA)). Berlin, F.R. Germany; Springer (1975). 164p.

With figs. and refs.

The electric probe is used as a fundamental diagnostic tool for measuring the local properties of a plasma. Fundamental definitions and key parameters governing the electric-probe measurement technique are given. The response of electric probes operating in the collisionless and transitional regimes in both quiescent and flowing plasmas are considered too. The continuum electrostatic probes measuring the upper limit of 'many collisions' within the plasma sheath are studied. Furthermore, some special topics are discussed such as: a) probe-surface phenomena, b) laminar plasmas with negative ions, c) strongly ionised plasmas, d) turbulent plasmas, and e) plasmas in magnetic fields. An appendix gives a survey on the general theory based on the Boltzmann and Poisson equations.

4238 **Ionisation of a high density plasma heated by a CO_2 laser.** Popovics, C. (Ecole Polytechnique, 91 - Palaiseau (France)). *J. Phys. (Paris)*; **36**: No. 11, 1089-1094(Nov 1975). (In French).

The line intensity ratio method for the spectroscopic measurement of electronic temperature has been investigated in the case of fast heating of a high density plasma by a CO_2 laser. The populations of ionic species of the plasma are determined by a transient model used to calculate the electronic temperature from the experimental data. Evidence is given of an increase in the electronic temperature of the plasma due to absorption of CO_2 laser energy.

4239 **Laser scattering with a rapidly tuned dye laser.** Kopainsky, J. (Technische Univ. Muenchen (F.R. Germany). Elektrophysikalisches Inst.). *Appl. Phys.*; **8**: No. 3, 229-239(Nov 1975).

12 figs.; 36 refs.

A facility is described for the measurement of the total spectrum produced by laser radiation scattered from a plasma during one laser pulse. The dye laser is electrooptically tuned by a high frequency voltage applied to a modified Lyot filter within its cavity. The scattered spectrum is registrated together with the laser reference signal by a transient recorder and processed afterwards. With the aid of this new scattering technique both measuring time and inaccuracy could be reduced drastically compared to spectroscopic methods.

4240 **An infrared lateral shearing interferometer for plasma diagnostic and infrared optical components testing.** Apostol, D.; Apostol, I.; Mihailescu, I.N. (Institutul de Fizica Atomica, Bucharest (Romania)). *Infrared Phys.*; **16**: No. 1-2, 269-271(Jan 1976).

From International conference on infrared physics; Zurich, Switzerland (11 Aug 1975).

An infrared lateral shearing interferometer using a germanium plate illuminated by a TEA-CO_2 laser is described. Excellent definition fringe patterns were obtained using normal thermal printer paper. Preliminary tests have also been undertaken on NaCl, KCl and germanium components. The possibilities of using this simple, inexpensive interferometer for plasma diagnostics are emphasised. It is possible to detect an order of magnitude lower minimum electron density without any alignment or stability difficulty. For fast transient plasmas high-speed cameras and more sensitive detectors would have to be used.

4241 **Infrared plasma diagnostics with lasers.** Holzhauer, E. (Stuttgart Univ. (TH) (F.R. Germany). Inst. fuer Plasmaforschung). *Infrared Phys.*; **16**: No. 1-2, 135-143(Jan 1976).

From International conference on infrared physics; Zurich, Switzerland (11 Aug 1975).

Infrared lasers have rendered possible measurements of plasma parameters in a range nor accessible using either optical or microwave techniques. Diagnostic methods based on the refraction and scattering of radiation by free electrons are discussed.

4242 **Spectroscopic observations of the plasma generated with the 1 GW output of a carbon dioxide laser.** Bromage, G.E. (Science Research Council, Abingdon (UK). Astrophysics Research Unit); Donaldson, T.P.; Fawcett, B.C. ; Spalding, I.J. *J. Phys., D (London)*; **9**: No. 3, L33-L36(21 Feb 1976).

Letter to the editor.

4243 **Field measurements in a pinch discharge using a magneto-optical probe.** Smeulders, P. (UKAEA Research Group, Abingdon. Culham Lab.). *J. Phys., D (London)*; **9**: No. 3, 413-421(21 Feb 1976).

This paper describes a miniature shaped glass magneto-optical probe. Its performance is measured and compared in a fast linear combined theta/z pinch device with that of a conventional induction probe. Because of the very good time response of the magneto-optical probe, fast changes in the axial current distribution are seen. The information obtained is new and was not found with the induction probe. Typically a field of 20 G and a bandwidth of 50 MHz is measured in the experiments described here.

4244 **Measurement of low electronic temperatures in unmagnetized plasmas.** Debrie, R. (Orleans Univ., 45 (France)); Arnal, Y.; Illiano, J.M. (C.R.P.E./C.N.R.S., Orleans, France). *Phys. Lett., A*; **56**: No. 2, 95-96(8 Mar 1976).

The measurement of low electron temperatures in a flowing unmagnetized argon plasma has been obtained by two methods: mutual impedance of a radiofrequency probe and of an electrostatic probe. The agreement between both methods is better than 5%.

PLASMA KINETICS - GENERAL

4245 (IPF—74-9) **Experimental and theoretical investigation of the extra-thermal conductivity of a supersonic flow during current flow.** Frey, H. (Stuttgart Univ. (TH) (Germany, F.R.). Inst. fuer Plasmaforschung). 1974. 108p. (In German). INIS.

54 refs.; with figs.

This is an investigation into increased electrical conductivity in a supersonic plasma flow with the aid of super-thermal ionization. The rare gas plasma is produced in a gas-dynamical membrane shock wave tube. Measured were the flow variables as well as the state variables. On the basis of a multi-component theory a simplified plasma flow model was used to evaluate its non-equilibrium behaviour. Experimental and theoretical conclusions resulted in mathematical interrelationships 1) for decelerating supersonic flow due to Ohmic heating of the electron components and energy transfer by means of elastic collisions on heavy particles, 2) concerning the decreasing rise in the temperature of electrons at increasing pressure and 3) for the interdependence between electrical conductivity and electron density.

4246 (UCRL—77640) **Computation of Mach reflection from rigid and yielding surfaces.** Buckingham, A.C.; Wilson, S.S. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1976. Contract W-7405-Eng-48. 34p. (CONF-760708—2). Dep. NTIS $4.00.

From 11. thermophysics conference; San Diego, California, United States of America (USA) (14 Jul 1976).

The present discussion centers on a theoretical description of one aspect of the irregular or Mach reflection from solid surfaces. The discussion is restricted to analytical considerations and some preliminary results using model approximations to the surface interaction phenomena. Currently, full numerical simulations of the irregular reflection surface interaction dynamics have not been obtained since the method is still under development. Discussion of the numerical method is, therefore, restricted to some special procedures for the gas-solid surface boundary dynamics. The discussion is divided into an introductory section briefly describing a particular Mach reflection process. Subsequently, some of the considerations on boundary conditions are submitted for numerical treatment of the gas-solid interface. Analysis and discussion of a yielding solid surface subjected to impulsive loading from an intense gas shock wave follows. This is used as a guide for the development of the numerical procedure. Mach reflection processes are then briefly reviewed with special attention for similitude and singular perturbation features.

4247 Plasma acceleration in crossed electric and magnetic fields. Aref'ev, V.I. *Sov. Phys. - Tech. Phys. (Engl. Transl.);* **19**: No. 4, 446-454(Oct 1974).

A model of a plane accelerating current sheath is used to investigate the turbulence ion-acceleration mechanism. Quasilinear theory, which describes weakly turbulent processes in the plasma, is used to study the development of the most dangerous transverse (Hall) current-driven instabilities, which produce a large contribution to the anomalous resistance of the plasma and lead to turbulence acceleration. The anode and pulsed current sheaths are investigated with allowance for the self-consistent anomalous resistance.

4248 On the interpretation of intensity anomalies in dense aluminium plasmas. Jamelot, G.; Carillon, A.; Jaegle, P.; Sureau, A. (Paris-11 Univ., 91 - Orsay (France)). *J. Phys. (Paris), Lett.;* **36**: No. 12, L.293-L.295(Dec 1975).

A numerical model is used to predict the behaviour of discrete emission and absorption spectra in non-homogeneous plasmas when the populations are in equilibrium. The evidence of a disagreement between this prediction and experiment is given for three peculiar lines of the Al^{3+} ion in a laser produced plasma. Dielectronic recombination is invoked as a likely channel leading to an extra population for one of the excited levels of the Al^{3+} ion. This conjecture is supported by the experimental observations.

4249 The violation of similarity laws in electrical discharges in gases. Lozansky, E.D.; Pontecorvo, G.B. (Joint Inst. for Nuclear Research, Dubna (USSR)). *J. Phys., D (London);* **9**: No. 3, L37-L39(21 Feb 1976).

Letter to the editor.

4250 Influence of a negatively biased grid on the plasma in a single-ended Q-machine. Popa, G. (Innsbruck Univ. (Austria). Inst. fuer Theoretische Physik); Sato, N.; Maerk, E.; Schrittwieser, R.; Mravlag, E. *J. Phys., D (London);* **9**: No. 3, 397-405(21 Feb 1976).

An experiment on an ion space charge instability is reported using a single-ended Q-machine. A negatively biased grid was inserted between the hot plate and the cold end-plate, and an ion space charge was observed between the grid and the cold plate when the latter was biased in order to reflect ions. The ions were reflected by the cold plate or the ion space charge and partly penetrated the grid back into the plasma. Under some boundary conditions specified by the grid, the cold plate potential and the plasma density, the potential distribution between the grid and the cold plate became unstable and ion space charge instability was observed. The oscillation frequency is given by the ion transit time through the grid from the plasma region into the space charge region.

4251 The temporal evolution of population densities of excited states in atomic oxygen thin plasmas. Cacciatore, M. (Centro di Studio per la Chimica dei Plasmi del C.N.R.); Capitelli, M. *J. Quant. Spectrosc. Radiat. Transfer;* **16**: No. 4, 325-334(Apr 1976).

Population densities of transient oxygen plasmas have been calculated solving a system of differential equations, which describes the temporal evolution of the considered quantum levels. The results, which refer to a temperature of 1 eV and to electron number densities ranging from 10^9 to 10^{14} cm^{-3}, show the strong importance of the metastable $3s^5S$ state in determining the evolution of these plasmas. The present results are then applied to the calculation of relaxation times of selected quantum levels and to the definition of quasistationary conditions of plasmas having low lying excited states (i.e. states belonging to the same principal quantum number as the ground state).

4252 Line intensity fluctuations from dense plasmas. Hey, J.D. (Cape Town Univ. (South Africa). Dept. of Physics). *J. Quant. Spectrosc. Radiat. Transfer;* **16**: No. 4, 373-376(Apr 1976).

The problem is considered of relating small 'shot-to-shot' variations in spectral line intensity radiated by a given dense plasma, to the corresponding variations in electron density and temperature. For the specific example of hydrogen lines from a helium-hydrogen plasma, generated in a device such as an electromagnetically driven shock tube, a clear distinction is shown between intensity fluctuations due to density changes, and those due to temperature changes. Thereby, the possibility is indicated of reducing the scatter in experimental data on spectral line shapes by simple first-order corrections.

PLASMA KINETICS - EXPERIMENTAL

4253 (JAERI-M—6096) Effect of a radical electric field on the impurity transport. Tuda, T. (Japan Atomic Energy Research Inst., Tokyo). Apr 1975. 11p. (In Japanese). INIS.

The problem of impurity transport in a Tokamak plasma is reconsidered, taking account of the radial electric field. Heavy impurity ions do not penetrate into the plasma column when the positive potential of the plasma exceeds a certain level.

PLASMA KINETICS - THEORETICAL

4254 (LA—6391-MS) Temperature- and density-dependent x-ray scattering in a low-Z plasma. Brown, R.T. (Los Alamos Scientific Lab., N.Mex, (USA)). Jun 1976. Contract W-7405-ENG-36. 12p. Dep. NTIS $3.50.

A computer program is described which calculates temperature- and density-dependent differential and total coherent and incoherent x-ray scattering cross sections for a low-Z scattering medium. Temperature and density are arbitrary within the limitations of the validity of local thermodynamic equilbrium, since ionic populations are calculated under this assumption. Scattering cross sections are calculated in the form factor approximation. The scattering medium may consist of any mixure of elements with Z less than or equal to 8, with this limitation imposed by the availability of atomic data.

4255 (UCID—17179) Physics options in the plasma code VOA. Eltgroth, P.G. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jun 1976. Contract W-7405-Eng-48. 15p. Dep. NTIS $3.50.

A two dimensional relativistic plasma physics code has been modified to accomodate general electromagnetic boundary conditions and various approximations of basic physics. The code can treat internal conductors and insulators, imposed electromagnetic fields, the effects of external circuitry and non-equilibrium starting conditions. Particle dynamics options include a full microscopic treatment, fully relaxed electrons, a low frequency electron approximation and a combination of approximations for specified zones. Electromagnetic options include the full wave treatment, an electrostatic approximation and two varieties of magnetohydrodynamic approximations in specified zones.

4256 Relaxation of toroidal plasma and generation of reverse magnetic fields. Taylor, J.B. (Culham Lab, Abingdon, Berkshire, Engl). *Phys. Rev. Lett.;* **33**: No. 19, 1139-1141(4 Nov 1974).

The spontaneous generation of reversed fields in toroidal plasmas is shown to be a consequence of relaxation under constraints. With perfect conductivity a topological constraint exists for each field line and the final state is not unique. With small departures from perfect conductivity, topological constraints are relaxed and the final state becomes unique. The onset of the reversed field and other features of this model agree well with observations on ZETA.

4257 Radiation processes from hot plasmas in a strong magnetic field. El-Khishen, M.; El-Gowhari, A.; El-Lakani, A. (Cairo Univ. (Egypt). Dept. of Physics). *Atomkernenergie;* **27**: No. 1, 49-52(1976).

2 figs.; 9 refs.

The non-relativistic expression for low-frequency electromagnetic radiation due to bremsstrahlung in the presence of a strong magnetic field ($B >= 10^{11}$ Gauss) is obtained by using the exact solution of the Schroedinger equation for an electron in a strong magnetic field and a Coulomb field of the ions. The results can be applied to case of a hot plasma in a magnetic field (neutron stars).

4258 Scaling theory of relaxation and fluctuation near the instability point. Suzuki, M. (Tokyo Univ. (Japan). Dept. of Physics). *Phys. Lett., A;* **56**: No. 2, 71-72(8 Mar 1976).

The idea of generalized scale transformation of time is introduced to evaluate asymptotically the relaxation and fluctuation

in non-equilibrium systems. This scaling theory is demonstrated to be very powerful in discussing the relaxation just from the instability point.

4259 Multigroup treatment of neutral transport in plasmas. El Derini, Z.; Gelbard, E.M. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.*; **23**: 45-46(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

4260 Impurity radiation losses from oxygen in a plasma. Hopkins, G.R. (General Atomic Co., San Diego, CA). *Trans. Am. Nucl. Soc.*; **23**: 46-47(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

4261 Core-corona model for tokamak reactor plasma simulation. Stacey, W.M. Jr.; Brooks, J.N. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.*; **23**: 47(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

4262 PHD, a plasma hydrodynamics code for laser-fusion simulation studies. Moses, G.A. (Univ. of Wisconsin, Madison) Duderstadt, J.J. *Trans. Am. Nucl. Soc.*; **23**: 50(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

4263 Transport equations in axisymmetric toroidal coordinates. Gralnick, S.L. (Princeton Univ., NJ). *Nucl. Sci. Eng.*; **60**: No. 3, 302-310(Jul 1976).

A derivation is presented of the conservation-law form of the single energy group transport equation in an axisymmetric toroidal coordinate system formed by rotating a nest of smooth, simply closed, plane curves of arbitrary parametric description about an axis that does not intersect the nest. This general equation can be used for generating equations specific to particular cross-section geometries or as the basis of a finite difference equation for the general case. The effect of both the toroidal and poloidal curvatures of the system are investigated, and criteria for the validity of cylindrical and planar approximations are established. The diffusion equation for this geometry is derived, and it is shown to be formally homologous to the "r-theta" cylindrical diffusion equation if the coordinate system is orthogonal and if the azimuthal coordinate, phi, can be ignored.

PLASMA PRODUCTION

REFER ALSO TO CITATION(S) 4242, 4262

4264 (IPP—4/129) **Expansion of polyethylene pellets irradiated by a neodymium laser.** Ariga, S.; Buechl, K.; Haering, T. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (Germany, F.R.)). Jan 1975. 6p. INIS.

11 figs.; 1 tab.

The expansion of polyethylene pellets (200 μ diameter) after irradiation by a Nd laser pulse has been investigated by shadowgram diagnostics. Only a small part of the pellet is converted into hot plasma. For short pulses (5 nsec) the rest of the pellet explodes mainly into small pieces of solid matter. For long pulses (50 nsec) a part of the pellet becomes a dense gas or cold plasma. With increasing pulse energy the portion of solid pieces decreases and the portion of cold plasma increases. These results suggest a pre-pulse method for plasma production from pellets.

4265 Electron energy distribution in a helium plasma created by nuclear radiations. Lo, R.H.; Miley, G.H. (Univ of Ill, Urbana). *IEEE Trans. Plasma Sci.*; **PS-2**: No. 4, 198-205(Dec 1974).

An integral balance technique for calculation of the electron energy distribution in a radiation-induced plasma is described. Results predict W-values reasonably well and compare favorably with more complicated Monte Carlo calculations. The distribution found differs from that in a normal electrical discharge and is of interest in radiation-pumped laser research.

4266 Electron beam initiated fusion neutron generator. Roberts, T.G.; Shatas, R.A.; Stettler, J.D. (US Army Missile Command, Redstone Arsenal, Ala). *IEEE Trans. Plasma Sci.*; **PS-2**: No. 4, 257-260(Dec 1974).

An experimental scheme is proposed which seems to satisfy all the requirements for use of a high energy electron beam to initiate a thermonuclear plasma. One-dimensional expansion is utilized to obtain confinement times longer than the pulse length of the electron beams. A magnetic field is used to limit the radial heat conductivity, and also serves as a guiding field for the electron beams when they are in the vicinity of the target. Two opposing electron beams are employed and the forces produced by these counterstreaming currents in the overlap region of the beams are sufficient to stop the beams within the target.

4267 The interaction of CO_2 laser radiation with various solid targets. Dyer, P.E.; Ramsden, S.A.; Sayers, J.A.; Skipper, M.A. (Hull Univ. (UK). Dept. of Applied Physics). *J. Phys., D (London)*; **9**: No. 3, 373-382(21 Feb 1976).

The results of a study of the interaction of 60 ns pulses from a gain-switched TEA CO_2 laser with a range of solid targets are described. Measurements using charge collector probes and soft-x-ray detectors and results of the plasma backscatter are reported for laser flux densities up to 1.2×10^{11} W cm^{-2}.

4268 X-ray emission and hydrodynamic expansion of plane carbon targets under the influence of high-intensity laser radiation. Marsh, M.C.; Thompson, P.C. (Atomic Weapons Research Establishment, Aldermaston (UK)). *J. Phys., D (London)*; **9**: No. 3, 383-396(21 Feb 1976).

The response of a carbon slab to high-intensity irradiation is calculated using a plane 1-D hydrodynamics code. Partial ionization of the resultant plasma is calculated using local thermodynamic equilibrium, but radiation transport is treated independently by a multigroup S_2 method. Results, including expansion velocity and the conversion efficiency of laser light to x-rays, are presented for peak-power densities in the range 10^{13} to 10^{16} W cm^{-2} and pulse durations of 100 ps to 10 ns. The effects of laser wavelength and line emission are discussed and a criterion for the applicability of the LTE ionization model is given. It is found that in the range of validity of the LTE model the x-ray conversion efficiency is a weakly increasing function of power density, with a value of about 10 %. The time-integrated emission spectrum shows a low-temperature Planckian component carrying most of the energy, with a high-temperature bremsstrahlung tail superimposed.

PLASMA INSTABILITIES

4269 (MATT—1254) **Electrostatic ion cyclotron instabilities driven by parallel ion beam injection.** Yamada, M.; Seiler, S.; Hendel, H.W.; Ikezi, H. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Jul 1976. Contract E(11-1)-3073. 36p. Dep. NTIS $4.00.

The detailed identification is presented for two instabilities driven by an ion beam injected parallel to the confining magnetic field, a resonant ion cyclotron instability and a nonresonant ion cyclotron drift wave driven by the beam's density gradient. Experimental results are in good agreement with numerical calculations based on the kinetic Vlasov equations. Quasi-linear velocity space diffusion of the beam ions by wave-particle interaction is observed, demonstrating enhanced energy transfer. The relevance of these results to Tokamak neutral beam injection heating is discussed.

4270 (MATT—1264) **Some nonlinear effects in tearing mode instability.** Kaw, P. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Jun 1976. Contract E(11-1)-3073. 18p. (CONF-760635—5). Dep. NTIS $3.50.

From Nobel symposium on nonlinear effects in plasmas; Lerum, Sweden (11 Jun 1976).

Two nonlinear effects which may be of relevance in the development of tearing mode instability are discussed: (a) effect of a given background turbulence of drift waves on the growth of tearing modes, and (b) effect of a plasma flow towards the X points on nonlinear growth of tearing modes. The possible relevance of the latter process to disruptive instability in tokamaks is also discussed.

4271 (MATT—1266) **Quenching of the current-driven ion-wave instability in the trapped-electron regime in a toroidal plasma.** Arunasalam, V.; Okabayashi, M.; Hawryluk, R.J.; Suckewer, S. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Jul 1976. Contract E(11-1)-3073. 56p. Dep. NTIS $4.50.

An analysis is presented of an experimental study of the scattering of microwaves by density fluctuations due to the current-driven ion acoustic wave instability in a toroidal plasma confinement device, the FM-1 spherator. It is found that the instability exists only in the collisional regime (where ν/sub eff/ is greater than ω/sub be/) and it is inhibited (i.e., quenched by two orders of magnitude) in the trapped-electron banana regime (where ν/sub eff/ is less than ω/sub be/). Further, it is found that for two different values of the ratio of the trapped to untrapped electron number density (i.e., for both 70 percent and 40 percent mirror trapping) this inhibition always starts to occur when ν/sub eff/ approximately equals ω/sub be/. Finally, it is shown that the nature of this inhibition is in general agreement with the recent theoretical notion that in the banana regime the entire Ohmic heating current is carried only by the freely circulating electrons.

4272 (ORNL/TM—5267) **Magnetohydrodynamic equilibria and local stability of axisymmetric tokamak plasmas.** Peng, Y.K.M.; Dory, R.A.; Nelson, D.B.; Sayer, R.O. (Oak Ridge National Lab., Tenn. (USA)). Jul 1976. Contract W-7405-eng-26. 50p. Dep. NTIS $4.00.

Axisymmetric magnetohydrodynamic equilibria are evaluated in terms of the Mercier Stability Criterion. The parameters of interest include poloidal beta (β/sub p/), current and pressure profile widths, D-shaped and doublet plasmas with elongation (sigma) and triangularity (δ), and the aspect ratio (A). For marginal local stability, the critical values of β, plasma current, and the safety factor q with fixed toroidal field at the geometric center of the plasma are obtained. It is shown that for a wide range of profiles in a D-shaped plasma with A = 3, the highest critical β occurs at β/sub p/ = 2.4, sigma = 1.65, and δ = 0.5. If the toroidal field at the coil surface is fixed, the highest critical pressure occurs near A approximately 3 to 4, given reasonable distance between the coils and the plasma edge. Calculations for a Doublet II-A plasma with sigma = 3 show that with similar pressure profile the highest critical β occurs at β/sub p/ = 1 and is 84 percent of the highest critical β for the D-shaped plasmas. Critical values of ohmic heating power density are also found to be comparable for the two plasma shapes. A D-shaped plasma with the above parameters is suggested for use in future high-β tokamak devices.

4273 **Parametric instabilities in inhomogeneous plasma regions with different background fluctuations.** Heymann, P.; Prinzler, H. (Zentralinstitut fuer Elektronenphysik, Berlin (German Democratic Republic)). pp v.1 p.323 of In Phenomena in ionized gases. Proceedings of the twelfth international conference held at Eindhoven, the Netherlands, 18-22 Aug 1975. Hoelscher, J.G.A.; Schram, D.C. (eds.). Amsterdam; North Holland Publishing Company (1975).

From 12. international conference on phenomena in ionized gases; Eindhoven, The Netherlands (18 Aug 1975).

The parametric process is investigated in inhomogeneous plasma regions formed by the sheath in front of an antenna or the wall near parts when using Tonks—Dattner (TD) modes. The mechanism favours ion sound waves with wavelength approximately equal to the scalelength of electron density variation. For sufficiently low background fluctuations the internal threshold field is determined considering the linear transformation problem; its high value (approximately 250 V/cm) is produced by the inhomogeneity effect. For strong background fluctuations no threshold is observed and parametric excitation coupled with a redistribution of fluctuations takes place in a broad frequency band up to the ion plasma frequency.

4274 **Preliminary thermal stability study of a two-component fusion plasma.** O'Farrill, C.G.; Campbell, H.D. (Univ. of Florida, Gainesville). *Trans. Am. Nucl. Soc.;* **23**: 51-53(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

PLASMA WAVE PHENOMENA

4275 **Faraday tarotion: new parameter for electromagnetic pulse propagation in magnetoplasma.** Bloch, S.C.; Lyons, P.W. (Univ. of South Florida, Tampa). *Proc. IEEE (Inst. Electr. Electron. Eng.);* **64**: No. 2, 224-228(Sum 1976).

Extreme distortion and time-dependent Faraday rotation occur for propagation of short electromagnetic pulses in magnetoplasma, for some ranges of plasma parameters. In order to relate pulse and monochromatic waves for propagation-path diagnostic purposes, a new parameter is introduced for the transmitted pulse train which has properties that correspond very accurately to results that would be expected for Faraday rotation of a continuous wave having the central frequency of the incident pulse spectrum. Results for 5-ns pulses (10 GHz) are presented for varying propagating length, static magnetic field, electron density, and collisional absorption.

4276 **On reflection and transmission of electromagnetic waves obliquely incident on relativistically moving uniaxial and isotropic plasma slabs.** Kalluri, D.; Shrivastava, R.K. (Birla Inst of Technol, Mesra, Ranchi, India). *IEEE Trans. Plasma Sci.;* **PS-2**: No. 4, 206-210(Dec 1974).

The oscillations in the power reflection coefficient as a function of the normalized slab velocity are shown for electromagnetic waves obliquely incident on a relativistically moving uniaxial plasma slab with an infinitely strong magneto-static field parallel to the slab boundaries. This paper also summarizes and concludes the sequence on the reflection and transmission of electromagnetic waves obliquely incident on relativistically moving uniaxial and isotropic plasma slabs.

4277 **Experimental investigation of second harmonic generation in a cyclotron and upper hybrid resonant plasma.** LaRose, A.R.; Tang, T.; Caron, P.R. (Univ of Mass, Amherst). *IEEE Trans. Plasma Sci.;* **PS-2**: No. 4, 291-296(Dec 1974).

The generation of the plasma and the second harmonic wave is associated with resonant conditions of electron cyclotron resonance and upper hybrid resonance. By adjusting the intensity of axial magnetic field, the second harmonic generation can be made solely due to the electron cyclotron resonance, the upper hybrid resonance or both. The experiment qualitatively agrees with previous similar experiments and can be explained in terms of the spatial variations of the magnetic field intensity and the electron number density. A technique for diagnosing peak number density is developed from the second harmonic power characteristics.

4278 **Nonlinear spectral broadening of backscattered light from laser-plasma interactions.** Anderson, D.; Wilhelmsson, H. (Chalmers Tekniska Hoegskola, Goeteborg (Sweden). Institutionen foer Elektromagnetisk Faeltteori). *Phys. Lett., A;* **56**: No. 1, 37-38(23 Feb 1976).

A qualitative model is given, which predicts nonlinear broadening of the spectrum of laser light anomalously reflected by a plasma. The predicted nonlinear broadening compares favourably with recent experimental results.

4279 **Inverse bremsstrahlung absorption in large radiation fields during binary collisions - classical theory. 2. Integrated rate coefficients for Coulomb collisions.** Pert, G.J. (Hull Univ. (UK). Dept. of Applied Physics). *J. Phys., A (London);* **9**: No. 3, 463-471(Mar 1976).

Integrated rate coefficients for the absorption of electromagnetic radiation in plasma when the plasma frequency is less than the radiation frequency are calculated from classical expressions derived earlier. The resulting formula is applicable over the complete range of field strengths. Numerical calculations are used to give useful interpolation formulae for the complete range of field strengths. The behaviour at high field strengths is discussed.

THERMONUCLEAR POWER PLANTS

REFER ALSO TO CITATION(S) 3319, 3331

4280 (ERI—75044) **Design aspects of a multipurpose fusion power plant for desalination and agrochemical processes.** Sabri, Z.A. (Iowa State Univ. of Science and Technology, Ames (USA). Engineering Research Inst.). Feb 1975. Contract E(11-1)-2457. 10p. (CONF-750371—1). Dep. NTIS $3.50.

From 1. conference on nuclear sciences and applications; Cairo, Egypt (22 Mar 1975).

A description is given of the skeletal structure of a multipurpose fusion power plant, designed for desalination and agrochemicals production. The plant is a complex that comprises dual purpose power and desalination units, separation and processing units for recovery of soluble salts in the effluent of the desalination unit, mariculture units for production of algae for food and as food for shrimp and other fish species. The electrical power unit is a two-component fusion device that burns deuterium and helium-3 utilizing a fast fusion cycle. (MOW)

4281 (RD/B/N—3263) **A review of the prospects for fusion power generation.** Hall, R.S.; Blow, S.; Clarke, R.H.; Tozer, B.A.; Whittingham, A.C.; Bending, R.C. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). Jul 1975. 112p. INIS.

The physics and engineering problems of both magnetically and inertially (laser) confined fusion systems are reviewed. The materials problems of the two systems are discussed, and their safety implications analysed. A short discussion is given of the possibilities and problems of a hybrid fission/fusion system.

4282 (UCRL-Trans—10776) **500-kV Theta-Pinch Project.** Herppich, G. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (Germany, F.R.)). Nov 1969. Translation of Projekt 500 kV-Theta-Pinch. 53p. Dep. NTIS $4.50.

The designed theta-pinch with a four-times fed coil (43 cm diameter, 100 cm length) will be driven by Blumlein-type transmission lines (0.58 Ω). The lines generate a 125 kV pulse (total voltage 500 kV at the closed circuit) of 500 ns length with a rise time constant of 85 ns. The corresponding field is 5.5 kG. The Blumlein lines are resonance charged by a capacitor bank of the Marx type. The start switches are pressurized multi-channel spark gaps. The bias field bank consists of two parts. One part is connected directly with the coil like the main bank. The other part feeds into two single-turn coils left and right of the main coil in order to produce a homogeneous field even 20 cm outside the main coil. Two smaller

Blumlein lines (100/200 ns) were built for studying technical and physical properties. Most of the electrical and discharge data are checked and computed with an ECAP program on the IBM 360/91.

4283 The possible contribution of nuclear fusion. Braams, C.M. (Stichting voor Fundamenteel Onderzoek der Materie, Jutphaas (Netherlands). Instituut voor Plasma-Fysica). *Atoomenerg. Haar Toepass.*; **18**: No. 2, 46-50(Feb 1976). (In Dutch).

Assuming that a practical fusion reactor can be developed to supply energy by the 21st century, the potential importance of the deuterium-tritium-lithium cycle is assessed. The radioactivity produced, and the proliferation and economic aspects are considered. The technical status of Tokamak systems, the JET project, and hybrid reactors is reviewed. A survey of developments in the European, Dutch and American fusion programmes is given.

4284 Review of General Atomic noncircular tokamak demonstration plant study. Kearney, D.W. (General Atomic Co., San Diego, CA). *Trans. Am. Nucl. Soc.*; **23**: 31(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

4285 Plasma physics constraints imposed on the reference theta-pinch reactor (RTPR) design. Thomassen, K.I.; Krakowski, R.A. (Los Alamos Scientific Lab., NM). *Trans. Am. Nucl. Soc.*; **23**: 40(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

4286 Low-exposure design concept permitting contract maintenance on a fusion reactor. Sager, P.H. (General Atomic Co., San Diego, CA). *Trans. Am. Nucl. Soc.*; **23**: 58(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

PHYSICS AND BLANKET ENGINEERING

REFER ALSO TO CITATION(S) 3489, 4253

4287 (CONF-760631—3) **Neutronics calculations for the Oak Ridge National Laboratory Tokamak Reactor Studies.** Santoro, R.T.; Baker, V.C.; Barnes, J.M. (Oak Ridge National Lab., Tenn. (USA)). 1976. 7p. Dep. NTIS $3.50.

From 9. symposium on fusion technology; Garmisch-Partenkirchen, German, Federal Republic of (F.R. Germany) (14 Jun 1976).

Neutronics calculations have been carried out to analyze the nuclear performance of conceptual blanket and shield designs for the Tokamak Experimental Power Reactor (EPR) and the Tokamak Demonstration Reactor Plant (DRP) being considered at the Oak Ridge National Laboratory. These reactor designs represent a sequence in the commercialization of fusion-generated electrical power. All of the calculations were carried out using the one-dimensional discrete ordinates code ANISN and the latest available ENDF/B-IV coupled neutron-gamma-ray transport cross-section data, fluence-to-kerma conversion factors, and radiation damage cross-section data. The calculations include spatial and integral heating-rate estimates in the reactor with emphasis on the recovery of fusion neutron energy in the blanket and limiting the heat-deposition rate in the superconducting toroidal field coils. Radiation damage due to atomic displacements and gas production produced in the reactor structural material and in the toroidal field coil windings were also estimated. The tritium-breeding ratio when natural lithium is used as the fertile material in the DRP blanket and in the experimental breeding modules in the EPR is also given.

4288 Progress on the validation of the CTR multigroup data package. Roussin, R.W. (Oak Ridge National Lab., TN); Weisbin, C.R.; White, J.E.; Greene, N.M.; Wright, R.Q.; Wright, J.B. *Trans. Am. Nucl. Soc.*; **23**: 14-15(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

4289 Advanced nuclear data processing methods for the fusion power program. MacFarlane, R.E.; Muir, D.W.; Barrett, R.J. (Los Alamos Scientific Lab., NM). *Trans. Am. Nucl. Soc.*; **23**: 16(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

4290 Few-group calculations on a benchmark CTR blanket. Evangelides, G. (Imperial Coll. of Science and Tech., London); Lindstrom, D. *Trans. Am. Nucl. Soc.*; **23**: 19(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

4291 Modified direct energy balance method for nuclear heating calculations. Woodruff, G.L. (Univ. of Washington, Seattle); Quimby, D.C. *Trans. Am. Nucl. Soc.*; **23**: 19-21(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

4292 Consistency analysis of fusion reactor neutronics data: tritium production. Reupke, W.A. (Georgia Inst. of Tech., Atlanta); Muir, D.W. *Trans. Am. Nucl. Soc.*; **23**: 21-22(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

4293 Use of high-energy ion rings for electronuclear energy production. Fleischmann, H.H. (Cornell Univ., Ithaca, NY). *Trans. Am. Nucl. Soc.*; **23**: 24(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

4294 Potential for fissile breeding with the fusion—fission hybrid reactor. Bender, D.J.; Lee, J.D. (Univ. of California, Livermore). *Trans. Am. Nucl. Soc.*; **23**: 24-25(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

4295 ^{233}U breeding and neutron multiplying blankets for fusion reactors. Cook, A.G. (Massachusetts Inst. of Tech., Cambridge); Maniscalco, J.A. *Trans. Am. Nucl. Soc.*; **23**: 25-26(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

4296 Comparative evaluation of fusion—fission actinide burner blanket concepts. Chi, J.W.H.; Holman, R.R. (Westinghouse Electric Corp., Pittsburgh). *Trans. Am. Nucl. Soc.*; **23**: 26-27(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

4297 Thermal-mechanical analysis of first-wall concepts for the reference theta-pinch reactor (RTPR). Krakowski, R.A.; Clinard, F.W. Jr. (Los Alamos Scientific Lab., NM). *Trans. Am. Nucl. Soc.*; **23**: 33-34(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

4298 Structural effects on fusion reactor blankets due to liquid metals in magnetic fields. Lehner, J.R.; Reich, M.; Powell, J.R. (Brookhaven National Lab., Upton, NY). *Trans. Am. Nucl. Soc.*; **23**: 35-36(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

4299 Neutronics studies of the gas-carried Li_2O cooling/breeding fusion reactor blanket and shield. Cheng, E.T.; Sung, T.Y.; Sze, D.K. (Univ. of Wisconsin, Madison). *Trans. Am. Nucl. Soc.*; **23**: 36-37(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

4300 Tritium recovery and handling in a gas-carried Li_2O CTR blanket. Larsen, E.M.; Clemmer, R.G.; Sze, D.K. (Univ. of Wisconsin, Madison). *Trans. Am. Nucl. Soc.*; **23**: 56(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

4301 Selected problems of fusion reactor shielding: an overview. Dudziak, D.J. (Los Alamos Scientific Lab., NM). *Trans. Am. Nucl. Soc.*; **23**: 626-628(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

MAGNET COILS AND FIELDS

REFER ALSO TO CITATION(S) 3660

4302 (CONF-761007—1) **Cryogenic instrumentation needs in the controlled thermonuclear research program.** Walstrom, P.L. (New South Wales Univ., Kensington (Australia). School of Physics). 1976. Contract W-7405-eng-26. 11p. Dep. NTIS $3.50.

From Conference on productivity through instrumentation and control; Houston, Texas, United States of America (USA) (10 Oct 1976).

The magnet development effort for the controlled thermonuclear research program will require extensive testing of superconducting coils at various sizes from small-scale models to full-size prototypes. Extensive use of diagnostic instrumentation will be required and to make detailed comparisons of predicted and actual performance in magnet tests and to monitor the test facility for incipient failure modes. At later stages of the program, cryogenic instrumentation will be required to monitor magnet system performance in fusion power reactors. Measured quantities may include temperature, strain, deflection, coil resistance, helium coolant pressure and flow, current, voltages, etc. The test environment, which includes high magnetic fields (up to 8-10 T) and low temperature, makes many commercial measuring devices inoperative or at least inaccurate. In order to ensure reliable measurements, careful screening of commercial devices for performance in the test environment will be required. A survey of potentially applicable instrumentation is presented along with available information on operation in the test environment based on experimental data or on analysis of the physical characteristics of the device. Areas where further development work is needed are delineated.

4303 **Symbiosis between beam-driven hybrid DT-fusion reactors and near-breeder HTGRs.** Seifritz, W. (Swiss Federal Inst. for Reactor Research, Wuerinlingen). *Trans. Am. Nucl. Soc.*; **23**: 27-30(Jun 1976).

From T; Toronto, Canada (13 Jun 1976).

4304 **Low-activity blanket with water-cooled first wall.** Benenati, R. (Polytechnic Inst. of New York, Brooklyn); Tichler, P.; Powell, J.R. *Trans. Am. Nucl. Soc.*; **23**: 32-33(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

4305 **Graphite blanket heat transfer for an experimental power reactor.** Fillo, J.A.; Benenati, R.; Powell, J.R. (Brookhaven National Lab., Upton, NY). *Trans. Am. Nucl. Soc.*; **23**: 34-35(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

4306 **Divertors for tokamak reactors.** Gralnick, L.S.; Meade, D.M.; Tenney, F.H. (Princeton Univ., NJ). *Trans. Am. Nucl. Soc.*; **23**: 38-39(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

4307 **CTR blanket and shield neutronics program.** Twining, B.G.; Coffman, F.E. (Energy Research and Development Administration, Washington, DC). *Trans. Am. Nucl. Soc.*; **23**: 626(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

4308 **Design of shielding for the tokamak fusion test reactor.** Jedruch, J. (Westinghouse Electric Corp., Pittsburgh). *Trans. Am. Nucl. Soc.*; **23**: 628(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

4309 **Gamma-ray dose rate after shutdown from a tokamak fusion reactor.** Vogelsang, W.F.; Ramer, E. (Univ. of Wisconsin, Madison). *Trans. Am. Nucl. Soc.*; **23**: 628-629(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

POWER SUPPLIES AND CIRCUITRY

4310 (ORNL-tr—4137) **Very exact superconducting commutation equipment.** Glukhikh, V.A.; Kostenko, A.I.; Monoszon, N.A.; Stolov, A.M.; Tizhchenko, V.A.; Trokhachev, G.V.; Yudakov, Yu.V. 1975. Translated from Russian. 8p. Dep. NTIS $3.50.

Results are presented of investigations on the development, design and technology of production of superconducting switches with a current-carrying element having no shunting superconductor of normal metal. (MOW)

FUEL SYSTEMS

4311 (LA—6344-MS) **STEEP4 code for computation of specific thermonuclear reaction rates from pointwise cross sections.** Harris, D.R.; Dei, D.E.; Husseiny, A.A.; Sabri, Z.A.; Hale, G.M. (Los Alamos Scientific Lab., N.Mex. (USA)). May 1976. Contract W-7405-ENG-36. 154p. Dep. NTIS $6.75.

A code module, STEEP4, is developed to calculate the fusion reaction rates in terms of the specific reactivity [sigma v] which is the product of cross section and relative velocity averaged over the actual ion distributions of the interacting particles in the plasma. The module is structured in a way suitable for incorporation in thermonuclear burn codes to provide rapid and yet relatively accurate on-line computation of [sigma v] as a function of plasma parameters. Ion distributions are modified to include slowing-down contributions which are characterized in terms of plasma parameters. Rapid and accurate algorithms are used for integrating [sigma v] from cross sections and spectra. The main program solves for [sigma v] by the method of steepest descent. However, options are provided to use Gauss-Hermite and dense trapezoidal quadrature integration techniques. Options are also provided for rapid calculation of screening effects on specific reaction rates. Although such effects are not significant in cases of plasmas of laboratory interest, the options are included to increase the range of applicability of the code. Gamow penetration form, log-log interpolation, and cubic interpolation routines are included to provide the interpolated values of cross sections.

4312 (LBL—4471) **120-keV neutral-beam injection system development.** Ehlers, K.W.; Berkner, K.H.; Cooper, W.S.; Haughian, J.M.; Kunkel, W.B.; Prichard, B.A. Jr.; Pyle, R.V.; Stearns, J.W. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Feb 1976. Contract W-7405-eng-48. 6p. (CONF-760631—8). Dep. NTIS $3.50.

From 9. symposium on fusion technology; Garmisch-Partenkirchen, German, Federal Republic of (F.R. Germany) (14 Jun 1976).

The neutral-beam injection systems for the next generation of U. S. fusion experiments (TFTR, MX, Doublet III) have requirements that considerably exceed the present state of development. TFTR, for example, desires 20 MW of 120-keV deuterium atoms in pulses of 0.5-sec duration. The neutral-beam systems needed to meet these demands will be large and complex and will require much development effort. In order to develop components for these new systems, a new, large test facility was constructed. The vacuum system, which has a volume in excess of 170,000 liters, will handle the pulsed gas loads by volume expansion; the gas will be pumped out in the one-minute intervals between pulses. The power-supply philosophy and specification are discussed in an accompanying paper. A mini-computer system will be used to monitor and control the power supplies and to diagnose the beam. Of the beam-line components, a plasma source and 120-kV accelerator structure which are under construction are discussed. A new long-pulse version of our 15-cm-diam high-current plasma source has been developed. Significant improvements have been made by re-orienting the filaments, so that they produce closed magnetic field lines near the wall, and by changing the shape and position of the anode. This new geometry has allowed considerable simplification in source construction. The accelerator structure is based on a computer-optimized design with four elements. The entrance-grid element is a 60 percent-transparent, 10-x 10-cm array of slots designed for an extraction-current density of approximately 0.25 A/cm^2.

4313 (ORNL-tr—4187) **Development of ion source for injection heating of the neutral particle beam.** Matsuda, S.; Ito, T.; Kondo, U.; Ohara, Y.; Oga, T.; Shibata, T.; Shiragata, H.; Sugawara, T.; Tanaka, S. 25 Feb 1976. Translated by H. Kubota from Japanese. 11p. Dep. NTIS $3.50.

Ion sources capable of output of 75 kV, 60 A, sustained duration 2 to 10 sec, and dispersion angle 1.2° are discussed. Some test stands to be used in the development of ion sources are described. Five different types of ion sources and electrodes are briefly mentioned. Some tests relating to aspect ratio, beam focusing, source plasma, and current extraction are described. (MOW)

4314 **Evaluated nuclear data for CTR applications.** Stewart, L.; Young, P.G. (Los Alamos Scientific Lab., NM). *Trans. Am. Nucl. Soc.*; **23**: 22-23(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

4315 Comparison of preliminary reference designs for D-T and catalyzed D-D reactors. Usher, J.L.; Powell, J.R. (Brookhaven National Lab., Upton, NY). *Trans. Am. Nucl. Soc.*; **23**: 31-32(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

4316 Pellet fueling for tokamaks. Turnbull, R.J. (Univ. of Illinois, Urbana). *Trans. Am. Nucl. Soc.*; **23**: 38(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

RADIATION HAZARDS

4317 (BNWL—2072) **Balanced biomedical program plan. Volume X. Fusion analysis for and environmental research.** (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Jun 1976. Contract E(45-1)-1830. 123p. Dep. NTIS $5.50.

In this draft planning document for health and environmental research needs relevant to the development of fusion technology, an attempt is made to integrate input from the participating laboratories on the basis of the King-Muir study categories. The general description covers only those concepts and features that are considered important to an understanding of possible and probable effects of thermonuclear reactors on health and the environment. Appendixes are included which reflect an understanding of three areas of special interest: materials requirements, effects from magnetic fields, and tritium effects.

4318 Assessment of a chemical getter for scavenging tritium from an inert gas. Maienschein, J.L. (Univ. of California, Livermore). *Trans. Am. Nucl. Soc.*; **23**: 56-57(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

4319 Exposure levels during hands-on maintenance of fusion reactors with minimum activity blankets. Lazareth, O.W.; Powell, J.R. (Brookhaven National Lab., Upton, NY). *Trans. Am. Nucl. Soc.*; **23**: 59(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

4320 Envelope of current CTR power plant design characteristics. Gore, B.F.; Kabele, T.J.; Hartley, J.N. (Battelle Pacific Northwest Labs., Richland, WA). *Trans. Am. Nucl. Soc.*; **23**: 55-56(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

4321 Minimization of the hazard resulting from fission-product transmutation. Parish, T.A.; Davidson, J.W.; Draper, E.L. Jr. (Univ. of Texas, Austin). *Trans. Am. Nucl. Soc.*; **23**: 59-60(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

POWER CONVERSION SYSTEMS

4322 Low-O tokamak reactor with high efficiency power cycle. Jassby, D.L. (Princeton Univ., NJ); Powell, J.R. *Trans. Am. Nucl. Soc.*; **23**: 47-49(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

INERTIAL CONFINEMENT SYSTEMS

REFER ALSO TO CITATION(S) 3675, 4235

4323 (EPRI-SR—14) **Survey of the laser-solenoid fusion reactor.** Amherd, N.A. (Electric Power Research Inst., Palo Alto, Calif. (USA)). Sep 1975. 58p. (PB—244649). NTIS $4.50.

This report surveys the prospects for a laser-solenoid fusion reactor. A sample reactor and scaling laws are used to describe the concept's characteristics. Experimental results are reviewed, and the laser and magnet technologies that undergird the laser-solenoid concept are analyzed. Finally, a systems analysis of fusion power reactors is given, including a discussion of direct conversion and fusion-fission effects, to ascertain the system attributes of the laser-solenoid configuration.

4324 (SAND—76-5724A) **Target irradiation experiments.** (Sandia Labs., Albuquerque, N.Mex. (USA)). 1976. Contract AT(29-1)-789. 5p. (CONF-760723—2). Dep. NTIS $3.50.

From Advisory group meeting on the technology of inertial confinement experiments; Dubna, Union of Soviet Socialist Republics (USSR) (19 Jul 1976).

Target irradiation experiments have been carried out on the Hydra accelerator, operating at powers between 0.15 and 0.3 TW. As listed in Table I, four types of spherical shell targets have been studied: 3 mm diameter, 200 μm and 50 μm wall thickness Au targets; 3 mm diameter, 300 μm wall thickness plastic targets; and 0.85 mm diameter, 10 μm wall thickness Ni targets. When compared to a practical range for 700 keV electrons, the ratio of shell thickness to electron range varied between 0.03 for the Ni targets to 1.5 for the thick walled Au targets. Multiple exposure optical holography was utilized to determine ablator velocity, and a one-dimensional hydrodynamical materials code CHARTD was utilized to model target response and infer beam deposition. Energy deposition varied from 1 TW/gm for thick Au targets up to 8 TW/gm for thin Ni targets, and pusher velocities ranged between 0.5 and 3.5 cm/μsec. Neutron production from D_2 and DT filled Ni exploding pusher targets was measured using Ag and Li activation counters and gated scintillator photomultiplier time of flight detectors.

4325 (UCRL—77064) **Determination of the laser intensity distribution at the target in low f/ No. focusing systems.** MacQuigg, D.R.; Holzrichter, J.F.; Hunt, J.T.; Swain, J.E.; Speck, D.R.; Storm, E.; Pettipiece, K.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1975. Contract W-7405-Eng-48. 32p. (CONF-751130—36). Dep. NTIS $4.00.

From APS meeting; St. Petersburg, Florida, USA (10 Nov 1975).

A series of experiments was conducted to obtain data on the energy distribution near focus of a typical high power glass laser system, the Janus laser at Lawrence Livermore Laboratory. Analysis of this data has provided a fairly complete picture of the time integrated energy distribution at several planes near the focus and at several power levels. Information on the temporal structure, that is, the intensity distribution at a particular time during the pulse, was obtained using a streak camera.

4326 (UCRL—77734) **Analysis of the fusion-effectiveness of active and passive pulse-stackers.** Harney, R.C.; Schipper, J.F. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 2 Aug 1976. Contract W-7405-eng-48. 16p. (CONF-760513—10). Dep. NTIS $3.50.

From 22. international instrumentation of the Instrument Society of America; San Diego, California, United States of America (USA) (25 May 1976).

The laser fusion effectiveness of various active and passive pulse-stacking schemes is investigated. Factors considered include efficiency, achievable rise-times, variety in output pulse shapes, simplicity of construction and operation, and compatibility with existing and proposed fusion laser systems. During the research phase of laser-fusion development a particular class of active pulse-stackers should be superior, although a passive system, such as the KMSF pulse-stacker, should be superior for use in a fusion reactor system.

4327 (UCRL—78411) **Theoretical tool movement required to diamond turn an off-axis paraboloid on axis.** Thompson, D.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 21 Jul 1976. Contract W-7405-Eng-48. 9p. (CONF-760832—6). Dep. NTIS $3.50.

From 20. annual SPIE technical symposium; San Diego, California, United States of America (USA) (23 Aug 1976).

Current techniques for manufacturing off-axis paraboloids are both expensive and insufficiently accurate. An alternative method, turning the workpiece about its axis on a diamond-turning machine, is presented, and the equations describing the necessary tool movement are derived. A discussion of a particular case suggests that the proposed technique is feasible.

4328 Comments on 'laser light forces and self-focusing in fully ionized plasmas'. Klima, R.; Petrzilka, V.A. (Czech Acad of Sci, Inst of Plasma Phys, Prague). *Phys. Fluids*; **17**: No. 8, 1640(Aug 1974).

An earlier derivation (Shearer and Eddleman, Phys. Fluids 16, 1753(1973) of basic equations describing the radiation pressure effects of laser radiation in plasma is discussed. Some inconsistances in their analysis are pointed out. It is pointed out that the multiplier term is not the proper term for the momentum density. A comment on collisional electron-ion interactions is also questioned.

4329 Optics in laser fusion. Trenholme, J.B. (Lawrence Livermore Lab., CA). pp 158-162 of In Optical design problems in laser systems. Sooy, W.R. (ed.). Palos Verdes Estates; Society of Photo-Optical Instrumentation Engineers (1975).

From SPIE national seminar on optical design problems in laser systems; San Diego, California, United States of America (USA) (21 Aug 1975).

See CONF-750887—.

A new approach to controlled thermonuclear fusion has recently become of interest. Laser light is used to compress and heat a small pellet containing deuterium and tritium. Energy is released in short times at high density, in contrast to the magnetic confinement approach utilizing long times at low density. Initial experiments are now underway to determine if this method is scientifically feasible. At the Lawrence Livermore Laboratory, a series of ever-larger Nd^{3+} glass lasers is being built in support of this effort. The culmination of this program will be the SHIVA laser system, a $20 million device which will put well over 10^{13} watts uniformly on a 200 μm target sphere. The design of such a laser system is governed by the desire to maximize the power per dollar, while avoiding damage to the laser. In addition, the target requires extremely uniform illumination and must be protected against destruction before the arrival of the main pulse. The target requirements, laser design problems, point and focus system, and focusing optics of the SHIVA system are considered.

4330 Laser, a tool for nuclear physics. Catier, E. *Electron. Microelectron. Ind.;* No. 210, 29-32(15 Oct 1975). (In French).

Some recent applications of lasers are described: plasma diagnostics by Thomson scattering, infrared interferometry, or holography; isotopic separation; thermonuclear fusion.

COMPONENT DEVELOPMENT AND TESTING

REFER ALSO TO CITATION(S) 3507, 4161

4331 (ANL—75-49, pp 4-21) **Dosimetry and Damage Analysis Center for DCTR materials research programs.** Heinrich, R.R.; Dudey, N.D. 1975.

In Chemical Engineering Division, fast-neutron dosimetry annual report, July 1974—June 1975.

Data are presented on the flux and fluences measured as a function of source-distance for several surface particle-emission experiments conducted at the Lawrence Livermore Laboratory (LLL) Rotating Target Neutron Source (RTNS). Three laboratories measured the γ activity of niobium dosimeter foils irradiated at the RTNS; a variation of about 6 percent was found among the three laboratories. Measurements of niobium recoils in silicon from the ^{93}Nb(n,2n) reaction appear to be within the limits of reported literature values. The neutron energy of 14.7 +- 0.2 MeV for several of these irradiations was determined by the nickel (n,p)/(n,2n) spectral index. A radial flux distribution of the neutron source measured for one experiment by means of the Au(n,2n)/(n,γ) reaction-rate ratio shows, as expected, more variation in the (n,2n) reaction than in the (n,γ) reaction. Characterizations of three irradiations at the LLL-Davis cyclograaff facility are presented. The first irradiation at a deuteron energy of 14-MeV indicated the presence of a strong low-energy component in the neutron spectrum, which was apparently due to scattered neutrons. Dosimetry results obtained from a SAND-2 computer code solution of two other Davis cyclograaff irradiations, in which 28 MeV deuterons were used in one and 40 MeV deuterons in the other, also indicate the existence of low-energy neutrons.

4332 (BNWL—1933) **Assessment of materials needs for fusion reactors.** Allison, G.S. (comp.). (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Jul 1976. Contract E(45-1)-1830. 145p. Dep. NTIS $6.00.

This report has the goal of presenting for the CTR designer and material supplier potentially significant problem areas in materials manufacturing and in structural material resources projected for potential application in fusion power reactor construction. The projected material requirements are based on presently available bills-of-materials for conceptual CTR designs used for constructing a hypothetical fusion power generating capacity of 10^6 MW(e) maturing exponentially over a 20-year period. The projected elemental requirements, the ratio of these requirements to the projected total U.S. demand, and the salient problems currently identified with the CTR use of these elements are summarized. The projected requirements are based upon a "model" industry, which is described, and the estimated potential use of molybdenum, niobium, vanadium, and tantalum as blanket structural materials.

4333 (CONF-750989—P1) **Radiation effects and tritium technology for fusion reactors. Volume I. Proceedings of the international conference, Gatlinburg, Tennessee, October 1—3, 1975.** Watson, J.S.; Wiffen, F.W.; Bishop, J.L.; Breeden, B.K. (eds.). (Oak Ridge National Lab., Tenn. (USA)). Mar 1976. 586p. Dep. NTIS $13.75.

From International conference on radiation effects and tritium technology for fusion reactors; Gatlinburg, Tennessee, USA (30 Sep 1975).

Separate abstracts were prepared for the 29 included papers in Vol. I. The topics covered in this volume include swelling and microstructures in thermonuclear reactor materials. Some papers on modeling and damage analysis are included. (MOW)

4334 (RLO—2225-T28-12) **Neutron interaction within the wall of a resistive solenoid.** Barreca, J.R. (Washington Univ., Seattle (USA)). 1974. Contract AT(45-1)-2225. 58p. Dep. NTIS $4.50.

Thesis.

The mechanical requirements of the solenoid design are examined. The magnetic stress in a non-helical, steady-state solenoid is studied along with the relationships between conductivity, current density, temperature, and time are explored. The nuclear aspects of the solenoid's design are reviewed. Two different designs were the source of input data used in neutron transport calculations. (MOW)

4335 Intense, energetic electron beam assisted fusion neutron generator. Roberts, T.G.; Shatas, R.A.; Meyer, H.C. III; Stettlerr, J.D. (to Secretary of the Army). US Patent 3,959,659. 25 May 1976. Filed date 4 Apr 1974. 6p.

An energetic electron beam assisted fusion neutron generator which comprises a plasma generator and an electron source interconnected by a pinch tube is described. Means for controlling the plasma generator, electron source, and the pinch tube to cause the electron source to be focused on the plasma from the plasma generator and to cause the electron source to be transmitted to the plasma of the plasma generator at the appropriate time to cause a maximum amount of neutrons to be produced by the interaction of the outputs of the plasma generator and the electron source through an appropriate gas filling the plasma generator are described.

4336 Two-dimensional neutron transport calculations in a Torus. Conn, R.W.; Gohar, Y.; Maynard, C.W. (Univ. of Wisconsin, Madison). *Trans. Am. Nucl. Soc.;* **23**: 12-14(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

4337 Maximum neutron wall loadings in beam-driven tokamak reactors. Towner, H.H.; Jassby, D.L. (Princeton Univ., NJ). *Trans. Am. Nucl. Soc.;* **23**: 41-42(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

4338 Calculations of the inelastic neutron spectra for 14-MeV neutrons. Hansen, L.F.; Grimes, S.M.; Howerton, R.J.; Anderson, J.D. (Univ. of California, Livermore). *Trans. Am. Nucl. Soc.;* **23**: 629-630(Jun 1976).

From Transactions of the American Nuclear Society 1976 annual meeting; Toronto, Canada (13 Jun 1976).

GENERAL AND MISCELLANEOUS

4339 (INIS-mf—3067) **Survey of the technical-scientific research field in the Oslo district.** (Oslo Univ. (Norway); Norges Teknisk-Naturvitenskapelige Forskningsraad, Oslo). Dec 1975. 155p. (In Norwegian). INIS.

Organisations and institutes in the Oslo district which carry out research in the technical-scientific field are listed, with address and telephone number. This includes a number of institutes whose activities are mainly or partly in the nuclear field. The list is subdivided into departments, with brief descriptions of their fields of activity, the scientific personnel with their special interests, and a detailed list of the special projects and activities of the departments. Special apparatus and equipment which the institutes have at their disposal are also mentioned with brief specifications.

4340 Transactions of the American Nuclear Society 1976 annual meeting, Toronto, Canada, June 13—18, 1976. Farmakes, R. (ed.). *Trans. Am. Nucl. Soc.;* **23**: 1-637(Jun 1976).

Each of the 595 brief summaries included is listed by title in NSA. The summaries cover sessions on aerospace and hydrospace,

controlled nuclear fusion, education, environmental sciences, isotopes and radiation, materials science and technology, mathematics and computation, nuclear criticality safety, nuclear fuel cycle, nuclear reactor safety, power, reactor operations, reactor physics, and shielding and dosimetry.

MANAGEMENT

4341 (ERDA—76-73) **Capsule summaries of plants and laboratories, FY 1975.** (Energy Research and Development Administration, Washington, D.C. (USA). Office of the Assistant Administrator for Field Operations). Aug 1976. 44p. Dep. NTIS $4.00.

This report briefly describes the extent and scope of ERDA's existing nationwide field organization. The field organization includes 16 production facilities, 39 laboratories and research centers, and 11 field operations offices that are located across the country. Of primary focus here are the 55 plants and laboratories. These are primarily government-owned contractor-operated facilities but also include government-owned and -operated laboratories and long-standing off-site university contractors. These plants and laboratories represent a cumulative investment of slightly over $12 billion. They employ nearly 93,000 persons, 99 percent of which are contractor employees; over 20,000 are working scientists and engineers. (RWR)

4342 **Emergency energy conservation programs.** *Fed. Regist. (Wash., D.C.)*; **41**: No. 137, 29125-29128(15 Jul 1976). (45CFR1061).

From Public Welfare, 45CFR1061, Community Services Administration—Character and scope of specific community action programs.

These revisions seek to achieve clarification and do not represent any major substantive changes in agency policy. The clarification the revisions seek is a designation of eligible activities using terminology that conforms with anticipated program account structures, amplification of the use of funds for administrative costs, clarification of the relationship of crisis intervention programs to other community support networks, an update of the program policy discussion to reflect the issuance of the "CSA Guide to Weatherization."

MATHEMATICS AND COMPUTERS

REFER ALSO TO CITATION(S) 3643

4343 (ANL—76-70) **Class notes for a PL/I course.** Dritz, K.W. (Argonne National Lab., Ill. (USA)). Nov 1975. Contract W-31-109-Eng-38. vp. Dep. NTIS $10.00.

Presented here are notes for a course in PL/I. They might serve as a guide to those who are developing a course, or as class notes for that course. They might be useful as a textbook independent of any course; as such a textbook, however, they are not self-contained because of the built-in assumption that they will supplement lectures and be accompanied by manuals. Very nearly the full language is taught here, with the emphasis on concepts rather than practical details. Discussion of I/O is avoided until roughly the midpoint of the course. The hoped-for consequence for students is an enhanced perception and understanding of the many concepts and their logical relationships. The dawning of the age of transportability for PL/I programs gives the user a reason, for the first time, to avoid convenient but illegal language.

4344 (BNWL—1987) **DIGRTS: a computer code for studying the diffusion of an inert gas in composite solids with reversible trapping.** Oster, C.A. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Feb 1976. Contract E(45-1)-1830. vp. Dep. NTIS $5.50.

DIGRTS is a computer program for calculating the concentration distribution of an inert gas diffusing through a composite solid which permits reversible trapping of the gas atoms. The program is coded entirely in FORTRAN IV. The composite solid can consist of up to ten regions. These regions are further subdivided in a manner so that the total number of nodes (subdivision points) is less than or equal to 200. The code can readily be modified should these limits be undesirable. The code permits only constant parameters for describing the diffusion process but the extension to allow time dependent parameters is clearly marked in the program. In addition to calculations of the concentration distributions, the time dependent release fraction is also computed. (auth)

4345 (COO—2383-0030) **Blended linear multistep methods.** Skeel, R.D.; Kong, A.K. (Illinois Univ., Urbana (USA). Dept. of Computer Science). Jun 1976. Contract AT(11-1)-2383. 73p. (UIUCDCS-R—76-800). Dep. NTIS $4.50.

The accuracy of linear multistep formulas suitable for stiff differential systems is limited. Greater accuracy can be attained by including higher derivatives in the formula, but this is not practical for all problems. It is possible, however, to duplicate the absolute stability region for any given m-derivative multistep formula by taking a linear combination of m multistep formulas. These blended formulas are similar to Lambert and Sigurdsson's linear multistep formulas with variable matrix coefficients, but the approach is different. Implementation details and numerical results are presented for a variable-order, variable-step blend of the Adams—Moulton and the backward differentiation formulas. 7 tables.

4346 (ORNL/CSD/TM—10) **MAPPROJ2: FORETRAN map projection subroutines, version 2.** Edwards, R.G. (Oak Ridge National Lab., Tenn. (USA)). Aug 1976. Contract W-7405-eng-26. 47p. Dep. NTIS $4.00.

The FORTRAN subroutine library MAPPROJ2 provides latitude—longitude—northing—easting transformations for Lambert, Albers, Polyconic, and Transverse-Mercator map projections. Four transformations are provided for each projection: latitude—longitude to northing—easting, northing—easting to latitude—longitude, latitude—easting to northing—longitude, and northing—longitude to latitude—easting. Two additional parametric "pseudo-projections" are provided, one for the various UTM zones, and the other for state plane definitions. Two versions of the routines are available, one for IBM 360 computers, the second for the PDP-10. 1 table.

4347 (ORNL/CSD/TM—12) **IUCALC: a FORTRAN subroutine for calculating polygon-line intersections, and polygon—polygon intersections, unions, and relative differences.** Edwards, R.G.; Coleman, P.R. (Oak Ridge National Lab., Tenn. (USA)). Aug 1976. Contract W-7405-eng-26. 35p. Dep. NTIS $4.00.

The IBM 360 FORTRAN Subroutine IUCALC may be used to calculate polygon—chain (of line segments) intersections and polygon—polygon intersections, unions, and relative differences. The subroutine is used in computer-assisted geographical analysis involving areal quantities defined in terms of polygons. The subroutine is also used in producing choropleth (shaded) displays of polygon or gridded data. 3 figures.

4348 (ORO—3443-61) **Singularities problem in the finite element method.** Babuska, I. (Maryland Univ., College Park (USA). Inst. for Fluid Dynamics and Applied Mathematics). Jun 1976. Contract AT(40-1)-3443. 49p. Dep. NTIS $4.00.

The problem of the influence of a nonsmooth boundary or interfaces on the convergence of the finite element method is important from the theoretical and practical points of view. In the case of linear problems, important results have been obtained recently. However, there are only a very few results which are related to the nonlinear problems. This paper attempts a survey of the current known results related to the problem of singular behavior of elliptic equations, especially with respect to numerical solutions. An extensive list of references is given. 7 figures, 4 tables.

4349 (PEM—51) **Nuclear EMP: tables of confidence bounds for failure probabilities.** Huebel, J.G.; Myers, G.K. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jun 1976. Contract W-7405-eng-48. 51p. Dep. NTIS $4.50.

The characteristics of a population cannot be determined precisely from the characteristics of a random sample taken from that population; therefore, sample characteristics can lead only to bounds for the population characteristics. The probability that these bounds are valid is called confidence. This report discusses the problems of determining population failure level bounds from sample failure levels and how confidence is influenced by sample size. Two sets of failure probability confidence bounds are tabulated. One set is derived for normally distributed populations and is based on the noncentral t distribution. The other set is derived nonparametrically—that is, without assuming the population distribution—and is based on the binomial distribution. These tables convert sample failure levels into population failure probability bounds. The tables are designed to be easily used and, consequently, are not set in the most compact format. In addition to presenting the tables, the report describes the basic statistical concepts, develops the mathematics on which the tables are based, and graphically compares the two methods. An example problem is given to illustrate the use of the tables. 12 figures, 32 tables.

4350 **Modularization of fault trees: a method to reduce the cost of analysis.** Chatterjee, P. (Stanford Research Inst., Menlo Park, CA). pp 101-126 of In Reliability and fault tree analysis. Barlow, R.E. (ed.). Philadelphia; Society for Industrial and Applied Mathematics (1975).

From Conference on reliability and fault tree analysis; Berkeley, California, USA (3 Sep 1974).

See CONF-740906—.

The problem of analyzing large fault trees is considered. The concept of the finest modular representation of a fault tree is introduced and an algorithm is presented for finding this representation. The algorithm will also identify trees which cannot be modularized. Applications of such modularizations are discussed.

4351 Computer scientist looks at reliability computations. Rosenthal, A. (Univ. of Michigan, Ann Arbor). pp 133-152 of In Reliability and fault tree analysis. Barlow, R.E. (ed.). Philadelphia; Society for Industrial and Applied Mathematics (1975).

From Conference on reliability and fault tree analysis; Berkeley, California, USA (3 Sep 1974).

See CONF-740906—.

Results from the theory of computational complexity are applied to reliability computations on fault trees and networks. A well known class of problems which almost certainly have no fast solution algorithms is presented. It is shown that even approximately computing the reliability of many systems is difficult enough to be in this class. In the face of this result, which indicates that for general systems the computation time will be exponential in the size of the system, decomposition techniques which can greatly reduce the effective size of a wide variety of realistic systems are explored.

4352 Importance sampling in reliability estimation. Mazumdar, M. (Westinghouse Research Labs., Pittsburgh). pp 153-163 of In Reliability and fault tree analysis. Barlow, R.E. (ed.). Philadelphia; Society for Industrial and Applied Mathematics (1975).

From Conference on reliability and fault tree analysis; Berkeley, California, USA (3 Sep 1974).

See CONF-740906—.

Exact reliability measures for large complex systems are often difficult to compute. When Monte Carlo methods are used and the failures are rare events, a large number of trials is required for reasonably precise estimates of failure probability. Importance sampling is a useful tool for efficient simulation. This technique depends on biasing the simulation through the use of another distribution so that the component or the combination of components that cause the unlikely event are emphasized in the sampling. So as not to bias the end result, corrections are made in the end. The method of importance sampling and certain techniques for choosing the "optimum" importance distribution which lead to efficient estimates of reliability are described. Some applications of this method to the evaluation of reliability of components of a fault tree are described.

4353 Set equation transformation system used in analysis of a typical naval weapon system. Atkinson, J.H. (Naval Weapons Evaluation Facility, Kirtland AFB, NM). pp 187-202 of In Reliability and fault tree analysis. Barlow, R.E. (ed.). Philadelphia; Society for Industrial and Applied Mathematics (1975).

From Conference on reliability and fault tree analysis; Berkeley, California, USA (3 Sep 1974).

See CONF-740906—.

Actual applications using the Set Equation Transformation System (SETS) computer program for the fault tree analysis of a complex military weapon system are discussed. It is shown how the equations for large fault trees can be generated in stages, and this, together with the use of developed and undeveloped events, results in considerable savings in computer time and core memory, as well as in engineering time and effort. Examples show the use of complemented events in a fault tree and demonstrate the need for an analytical capability that includes the modeling and processing of negated events.

4354 Applications of majorization and Schur functions in reliability and life testing. Proschan, F. (Florida State Univ., Tallahassee). pp 237-258 of In Reliability and fault tree analysis. Barlow, R.E. (ed.). Philadelphia; Society for Industrial and Applied Mathematics (1975).

From Conference on reliability and fault tree analysis; Berkeley, California, USA (3 Sep 1974).

See CONF-740906—.

This is an expository paper presenting basic definitions and properties of majorization and Schur functions, and displaying a variety of applications of these concepts in reliability prediction and modelling, and in reliability inference and life testing.

4355 Multivariate distributions with monotone hazard rate. Marshall, A.W. (Univ. of Rochester, NY). pp 259-284 of In Reliability and fault tree analysis. Barlow, R.E. (ed.). Philadelphia; Society for Industrial and Applied Mathematics (1975).

From Conference on reliability and fault tree analysis; Berkeley, California, USA (3 Sep 1974).

See CONF-740906—.

Several conditions concerning multivariate life distributions which imply that the univariate marginals have an increasing or decreasing hazard rate are compared. In addition, some models for dependence are investigated to determine some circumstances under which the various conditions are satisfied. In the differentiable case, the conditions are restated in terms of the hazard gradient, and a class of multivariate exponential distributions corresponding to each condition is determined. A number of examples and counterexamples is given.

4356 Continuous multivariate exponential extension. Block, H.W. (Univ. of Pittsburgh). pp 285-306 of In Reliability and fault tree analysis. Barlow, R.E. (ed.). Philadelphia; Society for Industrial and Applied Mathematics (1975).

From Conference on reliability and fault tree analysis; Berkeley, California, USA (3 Sep 1974).

See CONF-740906—.

The Freund-Weinman multivariate exponential extension is generalized to the case of nonidentically distributed marginal distributions. A fatal shock model is given for the resulting distribution. Results in the bivariate case and the concept of constant multivariate hazard rate lead to a continuous distribution related to the multivariate exponential distribution (MVE) of Marshall and Olkin. This distribution is shown to be a special case of the extended Freund-Weinman distribution. A generalization of the bivariate model of Proschan and Sullo leads to a distribution which contains both the extended Freund-Weinman distribution and the MVE.

4357 Total time on test processes and applications to failure data analysis. Barlow, R.E.; Campo, R. (Univ. of California, Berkeley). pp 451-481 of In Reliability and fault tree analysis. Barlow, R.E. (ed.). Philadelphia; Society for Industrial and Applied Mathematics (1975).

From Conference on reliability and fault tree analysis; Berkeley, California, USA (3 Sep 1974).

See CONF-740906—.

This paper describes a new method for analyzing data. The method applies to non-negative observations such as times to failure of devices and survival times of biological organisms and involves a plot of the data. These plots are useful in choosing a probabilistic model to represent the failure behavior of the data. They also furnish information about the failure rate function and aid in its estimation. An important feature of these data plots is that incomplete data can be analyzed. The underlying random variables are, however, assumed to be independent and identically distributed. The plots have a theoretical basis, and converge to a transform of the underlying probability distribution as the sample size increases.

4358 New approach to the determination of exact and approximate one-sided prediction intervals for normal and lognormal distributions, with tables. Fertig, K.W. (Rockwell International, Canoga Park, CA); Mann, N.R. pp 533-556 of In Reliability and fault tree analysis. Barlow, R.E. (ed.). Philadelphia; Society for Industrial and Applied Mathematics (1975).

From Conference on reliability and fault tree analysis; Berkeley, California, USA (3 Sep 1974).

See CONF-740906—.

It is assumed that n observations are to be randomly selected from a single normal or lognormal distribution. Further, it is desired that the sample mean and sample standard deviation be used to predict an interval within which a group of m future observations from the same distribution will lie with probability γ. Hahn performed numerical integration on a double integral defining the m-variate Student t-distribution, with n-1 degrees of freedom and with correlation matrix having all nondiagonal elements equal to $(n+1)^{-1}$, to compute iteratively and to tabulate exact values from which such prediction intervals can be obtained. Hahn also discussed methods for approximating these prediction intervals. An expression defining one-sided prediction intervals has been obtained in terms of the first order statistic from the future sample of size m. This allows for computation of the exact values for obtaining the one-sided prediction intervals by numerical integration of a single integral.

4359 Quantile selection procedure and assoiated distribution of ratios of order statistics from a restricted family of probability distributions. Gupta, S.S.; Panchapakesan, S. (Purdue Univ., Lafayette, IN). pp 557-576 of In Reliability and fault tree analysis. Barlow, R.E. (ed.). Philadelphia; Society for Industrial and Applied Mathematics (1975).

From Conference on reliability and fault tree analysis; Berkeley, California, USA (3 Sep 1974).

See CONF-740906—.

A quantile selection procedure in reliability problems pertaining to a restricted family of probability distributions is

discussed. This family is assumed to be star-ordered with respect to the standard normal distribution folded at the origin. Motivation for this formulation of the problem is described. Both exact and asymptotic results dealing with the distribution of the maximum of ratios of order statistics from such a family are obtained and tables of the appropriate constants, percentiles of this statistic, are given in order to facilitate the use of the selection procedure.

4360 Fundamental concepts and relations for reliability analysis of multi-state systems. Murchland, J.D. pp 581-618 of In Reliability and fault tree analysis. Barlow, R.E. (ed.). Philadelphia; Society for Industrial and Applied Mathematics (1975).

From Conference on reliability and fault tree analysis; Berkeley, California, USA (3 Sep 1974).

See CONF-740906—.

The fundamental concepts and relations that should be used in the reliability analysis of systems with numerous components are discussed, with an emphasis on calculable quantities. These are: (1) the average probability of being in a state, (2) the average transition rates between states, in the long run or as time functions, and (3) the integrals of the transition rates, which are the expected numbers of transitions. These quantities are related by the net transition relations, and the calculationally vital transition rate relation when the inputs of an item are statistically independent. Assumptions necessary for the existence of these quantities and for the relations are listed, and proofs given. The importance of exploiting the closeness to "simple" structure which systems may possess, and the versatility for different problems of a computational technique of "reduction" and "expansion" are discussed. The key relations for the latter are formally derived. Applications are made to fault trees, structure networks, undirected and directed communication networks.

4361 Network reliability analysis. II. Van Slyke, R.; Frank, H.; Kershenbaum, A. (Network Analysis Corp., Glen Cove, NY). pp 619-650 of In Reliability and fault tree analysis. Barlow, R.E. (ed.). Philadelphia; Society for Industrial and Applied Mathematics (1975).

From Conference on reliability and fault tree analysis; Berkeley, California, USA (3 Sep 1974).

See CONF-740906—.

Methods are given for relating the reliability of a network to the reliability of its randomly failing nodes and links. Networks are considered in which nodes can fail as well as links. Also, variations of the basic model are described which are useful in special situations.

4362 Software reliability: an overview. Amster, S.J.; Shooman, M.L. (Bell Telephone Labs., Inc., Holmdel, NJ). pp 655-685 of In Reliability and fault tree analysis. Barlow, R.E. (ed.). Philadelphia; Society for Industrial and Applied Mathematics (1975).

From Conference on reliability and fault tree analysis; Berkeley, California, USA (3 Sep 1974).

See CONF-740906—.

The growing importance of software reliability is briefly reviewed, some of the published data is summarized and a checklist for potential data collection problems is presented. This is followed by a discussion of several techniques for reliability improvement, remarks on their quantitative evaluation and suggestions for future directions.

4363 Survey of the design and analysis of fault-tolerant computers. Goldberg, J. (Stanford Research Inst., Menlo Park, CA). pp 687-731 of In Reliability and fault tree analysis. Barlow, R.E. (ed.). Philadelphia; Society for Industrial and Applied Mathematics (1975).

From Conference on reliability and fault tree analysis; Berkeley, California, USA (3 Sep 1974).

See CONF-740906—.

The art of designing and analyzing fault-tolerant computers is surveyed with special emphasis on problems of analyzing the behavior of computers that have autonomous repair capability. The survey covers the following topics: (1) general issues in computer reliability, (2) fault-tolerance state relations and requirements, (3) computational hierarchy, (4) fault characteristics, (5) fault diagnosis, (6) fault-tolerance schemes for logic networks and machines, (7) fault coverage effects, and (8) fault-tree analysis of coverage. The survey does not include techniques for verifying nonredundant hardware or system software designs or for verifying the correctness of application programs.

4364 Reliability and design aspects of digital subsystems with concurrent error detectors. Ramamoorthy, C.V.; Han, Y.W. (Univ. of California, Berkeley). pp 733-765 of In Reliability and fault tree analysis. Barlow, R.E. (ed.). Philadelphia; Society for Industrial and Applied Mathematics (1975).

From Conference on reliability and fault tree analysis; Berkeley, California, USA (3 Sep 1974).

See CONF-740906—.

System reliability is the most critical parameter in real time computers such as, those used in space flights, military command and control, assembly line and process control. Therefore even at the expense of reducing throughput rate, some fault tolerant schemes have been used to reach the goal of error-free computation. The use of error detectors and correctors in computer subsystems, such as, parity detectors in memory system and residue checkers in arithmetic units is considered. Detector redundant systems are modelled and their fault tolerant characteristics analyzed. The reliabilities and availabilities of these detector redundant systems are analyzed and compared with those which do not have such error detectors but have some other fault masking redundancies (e.g., N-tuple modular redundant systems, hybrid redundant systems). The reliabilities of the detectors in the detector redundant systems are also taken into consideration. The necessary and sufficient conditions under which they are more reliable than their counterparts without such capabilities are developed.

4365 Fault tree graphics. Bass, L.; Wynholds, H.W.; Porterfield, W.R. pp 913-927 of In Reliability and fault tree analysis. Barlow, R.E. (ed.). Philadelphia; Society for Industrial and Applied Mathematics (1975).

From Conference on reliability and fault tree analysis; Berkeley, California, USA (3 Sep 1974).

See CONF-740906—.

Described is an operational system that enables the user, through an intelligent graphics terminal, to construct, modify, analyze, and store fault trees. With this system, complex engineering designs can be analyzed. This paper discusses the system and its capabilities. Included is a brief discussion of fault tree analysis, which represents an aspect of reliability and safety modeling.

INFORMATION HANDLING

REFER ALSO TO CITATION(S) 3315, 3339

4366 (ORNL—5137, pp 89-91) **Nuclear Data Project.** Auble, R.L.; Harmatz, B.; Bertrand, F.E. May 1976.

In Physics Division annual progress report for period ending December 31, 1975.

1975 saw the culmination of Nuclear Data Project (NDP) efforts in several areas. The Evaluated Nuclear Structure Data File (ENSDF) was developed to where it can serve as the focus for NDP evaluation activities. Standard ENSDF data sets are used routinely to produce computer-printed nuclear data sheets as well as drawings. Additional output formats are being developed. The project's file of keyword-indexed references to nuclear structure literature was used in new ways during the year. References to experimental nuclear structure literature for 1969 to 1974 were placed on the RECON system for direct interactive search by any qualified user. (RWR)

CORPORATE INDEX

In the corporate index, report literature is indexed using the name of the organization or institution responsible for issuing the report. Headings are provided for all report literature and for published literature for which a corporate approach is especially desirable, e.g., symposium and conference proceedings.

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ERDA Energy Information Data Base) Corporate Author Entries "TID-4585" is used in the standardization of corporate entries. TID-4585 is available for purchase from the National Technical Information Service "NTIS", U. S. Department of Commerce, Springfield, Virginia 22161.

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The title may be supplemented with additional words, or a phrase, if it appears additional information would be helpful. In cases for which the title contains little or no information related to the subject entry, it may be replaced entirely by the supplementary information. A qualifier is not always required, and in such cases the title will follow the unqualified subject descriptor.

The descriptors selected for use as subject terms are generally the names of specific materials, things, or processes. To the extent possible, a qualifier is selected to describe the properties of, or processses applied to, the subject term.

Index entries are selected to indicate the important ideas and concepts presented in a document, rather than words that may appear in the text. Within the available thesaurus terms, the most probable or logical place to look for typical information is selected. "See references" are included to guide users from synonymous terms or phrases to the descriptor selected as a subject heading for the concept. (e.g. Pipeline Quality Gas see HIGH BTU GAS). "See also references" are used to indicate where to find references to subject concepts that are narrower, broader, or related to a particular subject heading. To complete an exhaustive search of a given subject, all such headings should be reviewed.

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2	2:3651	*See* Y/EN-61
CONF-760513-		
1	2:3487	Dep. NTIS, $3.50
10	2:4326	*See* UCRL-77734
CONF-760515-		
1	2:3506	*See* LA-UR-75-2353
CONF-760535-		
	2:2818	*See* CRBRP-PMC-76-04
CONF-760540-		
9	2:3461	*See* Y/DA-6666
11	2:3460	*See* Y/DA-6663
12	2:3480	*See* Y/DA-6664
13	2:3459	*See* Y/DA-6662
14	2:3481	*See* Y/DA-6667
CONF-760560-		
6	2:4147	*See* BNL-21403
CONF-760561-		
8	2:4111	*See* BNL-21464
9	2:4112	*See* COO-3001-149
10	2:4110	*See* COO-2171-59
CONF-760567-		
1	2:4130	*See* ORO-5126-2
CONF-760615-		
12	2:3574	*See* ARH-SA-248
CONF-760619-		
5	2:3642	*See* LBL-4805
CONF-760620-		
2	2:3615	*See* COO-3416-27
CONF-760622-		
5	2:2495	*See* BNL-21571
38	2:2815	Dep. NTIS, $3.50
CONF-760631-		
3	2:4287	Dep. NTIS, $3.50
8	2:4312	*See* LBL-4471

Report No.	Abstract No.	Availability
CONF-760632-3	2:3932	*See* BNL-21463
CONF-760634-4	2:3995	*See* UCRL-78409
5	2:3992	*See* LA-UR-76-1718
CONF-760635-5	2:4270	*See* MATT-1264
CONF-760643-2	2:3125	Dep. NTIS, $3.50
CONF-760644-3	2:3718	*See* BNL-21664
4	2:3719	*See* BNL-21728
CONF-760646-2	2:4046	*See* LA-UR-76-1315
CONF-760647-4	2:4151	*See* UCRL-78344
6	2:4163	*See* BNL-21560
CONF-760656-1	2:3878	Dep. NTIS, $3.50
CONF-760657-2	2:2623	*See* UCRL-77906
CONF-760658-2	2:3455	*See* LBL-5121
CONF-760661-1	2:3570	*See* ARH-SA-241
CONF-760668-1	2:3571	*See* ARH-SA-249
CONF-760701-9	2:2496	Dep. NTIS, $3.50
10	2:2526	*See* Y/OWI-7
11	2:2521	*See* LA-UR-76-1722
CONF-760703-4	2:3836	Dep. NTIS, $3.50
CONF-760708-2	2:4246	*See* UCRL-77640
CONF-760717-1	2:4181	*See* BNWL-SA-5828
CONF-760719-1	2:4095	*See* COO-1545-193
4	2:4093	*See* COO-1545-191
5	2:4094	*See* COO-1545-192
8	2:4105	*See* FERMILAB-Conf-76/50-THY
CONF-760723-2	2:4324	*See* SAND-76-5724A
CONF-760725-1	2:4086	*See* BNL-21621
CONF-760727-1	2:3780	*See* LA-UR-76-1445
CONF-760729-1	2:4092	*See* COO-1428-438
CONF-760801-4	2:2290	*See* UCRL-77627(Rev.1)
CONF-760803-4	2:4182	*See* UCRL-77839
10	2:2524	*See* SAND-76-5319
CONF-760805-20	2:3788	*See* SAND-76-5732
CONF-760811-2	2:4014	Dep. NTIS, $3.50
CONF-760813-11	2:3665	*See* SAND-76-5363
12	2:3664	*See* LA-UR-76-1701
CONF-760817-3	2:2292	*See* UCRL-78304
CONF-760821-11	2:2619	Dep. NTIS, $3.50
12	2:2576	*See* SAND-76-0411
CONF-760822-15	2:3662	*See* SAND-76-5231
CONF-760823-8	2:3640	Dep. NTIS, $4.50
CONF-760832-5	2:2603	*See* SAND-76-5759
6	2:4327	*See* UCRL-78411
11	2:2453	*See* LA-UR-76-1647
CONF-760833-1	2:3809	*See* UCRL-78037
2	2:3810	*See* UCRL-78092
CONF-760838-1	2:2277	Dep. NTIS, $3.50
CONF-760901-2	2:4047	*See* LBL-5114
CONF-760906-14	2:2900	*See* LA-UR-76-998
19	2:3295	*See* LBL-5186
20	2:2609	Dep. NTIS, $3.50
CONF-760908-1	2:3853	*See* BNL-20882
CONF-760913-1	2:2668	*See* BNL-20250
CONF-760914-1	2:3782	*See* LA-UR-76-1425
2	2:3783	*See* LA-UR-76-1426
3	2:3781	*See* LA-UR-76-1328
4	2:3388	*See* UCRL-78280
CONF-760918-4	2:3820	*See* BNL-21601
CONF-760921-2	2:3741	*See* BNL-21615
CONF-760922-7	2:3528	*See* BNL-21641
8	2:3589	*See* BNL-21675
CONF-760929-1	2:3540	Dep. NTIS, $3.50
CONF-760932-1	2:3648	*See* SAND-76-5157
CONF-761001-1	2:2816	Dep. NTIS, $3.50
CONF-761003-2	2:3807	Dep. NTIS, $3.50
4	2:3808	*See* COO-2455-7
7	2:3797	*See* LA-UR-76-1068
8	2:3795	*See* COO-2455-12
14	2:3805	*See* BNL-21416
CONF-761004-2	2:3456	*See* SAND-76-5292
3	2:3457	*See* SAND-76-5721
CONF-761006-1	2:3147	*See* UCRL-78126
CONF-761007-1	2:4302	Dep. NTIS, $3.50
2	2:3882	Dep. NTIS, $3.50
3	2:3386	*See* GAT-E-202
CONF-761008-2	2:2291	*See* UCRL-78302
3	2:2380	*See* SAND-76-533
CONF-761014-1	2:2548	*See* LA-UR-76-1310
CONF-761015-1	2:3362	*See* ANL-HEP-CP-76-29
CONF-761018-1	2:3253	*See* UCRL-78085
CONF-761201-1	2:3900	*See* UCRL-78412
COO-910-40	2:3929	Dep. NTIS, $3.50
1156-82	2:3846	Dep. NTIS, $3.50
1156-83	2:3841	Dep. NTIS, $7.75
1332-122	2:3883	Dep. NTIS, $4.00
1332-123	2:3847	Dep. NTIS, $4.50
1428-436	2:4075	Dep. NTIS, $3.50
1428-438	2:4092	Dep. NTIS, $3.50
1545-191	2:4093	Dep. NTIS, $3.50
1545-192	2:4094	Dep. NTIS, $3.50
1545-193	2:4095	Dep. NTIS, $3.50
1713-68	2:3636	Dep. NTIS, $3.50
2126—36	2:4051	Dep. NTIS, $3.50
2147-14	2:2561	Dep. NTIS, $4.50
2171-59	2:4110	Dep. NTIS, $3.50
2208-8	2:2562	Dep. NTIS, $3.50
2232A-32	2:4064	Dep. NTIS, $3.50
2245-26	2:2817	Dep. NTIS, $4.50
2271-45(Rev.)	2:4113	*See* RLO-2041-136
2283-7	2:3968	Dep. NTIS, $3.50
2354-2	2:3470	Dep. NTIS, $3.50
2362-21	2:3962	Dep. NTIS, $3.50
2383-0030	2:4345	Dep. NTIS, $4.50
2394-1	2:3073	Dep. NTIS, $13.00
2403-5	2:3911	Dep. NTIS, $4.00
2455-7	2:3808	Dep. NTIS, $4.50
2455-12	2:3795	Dep. NTIS, $3.50
2462-2	2:3500	Dep. NTIS, $3.50
2472-2	2:3907	Dep. NTIS, $3.50
2477-2(Rev.1)	2:2954	Dep. NTIS, $6.00
2479-9	2:4142	Dep. NTIS, $3.50
2497-07	2:3908	Dep. NTIS, $3.50
2502-5	2:3871	Dep. NTIS, $3.50
2510-11	2:2497	Dep. NTIS, $4.00
2630-15	2:3390	Dep. NTIS, $5.50

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2689-5	2:2519	Dep. NTIS, $3.50
2713-1	2:3524	Dep. NTIS, $3.50
2749-T6	2:3391	Dep. NTIS, $5.50
2749-T8	2:3392	Dep. NTIS, $5.00
2749-T9	2:3393	Dep. NTIS, $8.00
2754-1	2:3529	Dep. NTIS, $4.00
2802-1	2:3612	Dep. NTIS, $4.00
2851-1	2:3796	Dep. NTIS, $4.50
3001-149	2:4112	Dep. NTIS, $3.50
3069-404	2:4087	Dep. NTIS, $4.00
3122-10	2:4146	Dep. NTIS, $3.50
3127-11	2:3602	Dep. NTIS, $6.00
3127-14	2:3603	Dep. NTIS, $6.00
3139-23	2:3912	Dep. NTIS, $3.50
3151-61	2:3532	Dep. NTIS, $4.00
3151-63	2:3488	Dep. NTIS, $3.50
3153-127	2:3471	Dep. NTIS, $6.75
3153-128	2:3556	Dep. NTIS, $6.75
3153-129	2:3557	Dep. NTIS, $5.50
3153-141	2:3452	Dep. NTIS, $3.50
3225-24	2:3886	Dep. NTIS, $3.50
3231-4	2:3913	Dep. NTIS, $4.00
3247-34	2:4045	Dep. NTIS, $4.50
3253-5	2:3922	Dep. NTIS, $6.00
3254-32	2:3859	Dep. NTIS, $7.50
3380-27	2:3983	Dep. NTIS, $3.50
3416-27	2:3615	Dep. NTIS, $3.50
3435-29	2:3606	Dep. NTIS, $4.00
3459-10	2:3472	Dep. NTIS, $3.50
3476-12	2:3473	Dep. NTIS, $3.50
3496-56	2:4157	Dep. NTIS, $6.75
3563-36	2:3868	Dep. NTIS, $3.50
COO/2600-		
T1	2:2620	Dep. NTIS, $4.50
COO/2625-		
75/1	2:2621	Dep. NTIS, $6.75
COO/2626-		
76/T1	2:2614	Dep. NTIS, $6.75
COO-NSF-C-		
957-F	2:2621	*See* COO/2625-75/1
CPC-		
1-A(Rev.4)	2:2669	Dep. NTIS, $6.00
CRBRP-PMC-		
76-04	2:2818	AT
CRCE-		
1189	2:2787	*See* AECL-1913
CRWR-		
113	2:3341	Univ. of Texas, Austin
DEU-		
73-28(Ed.1974)	2:2670	INIS
DHEW/FDA-		
75-8007	2:3940	GPO
75-8017	2:3941	GPO
75-8020	2:3973	GPO, $2.35
75-8024(Rev.)	2:3974	GPO
DIN-		
1943	2:3023	Beuth (Feb 1975).
DOT-TSC-OST-		
76-22	2:3432	Dep. NTIS, $4.00
DOT-TST-		
76-50	2:3445	NTIS
DP-		
1394	2:4164	Dep. NTIS, $5.50
1417	2:2498	Dep. NTIS, $4.00
1418	2:2465	Dep. NTIS, $4.00
DP-TR-		
5	2:3482	Dep. NTIS, $4.00
DPSPU-		
76-302	2:3814	Dep. NTIS, $5.00
DPST-		
73-128-2	2:2564	Dep. NTIS, $3.50
75-138-2	2:2429	Dep. NTIS, $4.00
76-128-2	2:3639	Dep. NTIS, $4.00
76-138-2	2:2430	Dep. NTIS, $5.50
76-141-2	2:2431	Dep. NTIS, $5.00
DPST-LWR-		
76-1-1	2:2466	Dep. NTIS, $4.00
EIR-		
294	2:3254	Dep. NTIS (US Sales Only), $4.00
EPA-		
600/2-75-069-a	2:3377	*See* PB-248292
EPRI-		
11	2:3872	Electric Power Research Institute, Palo Alto, CA, $8.00
12	2:3873	Electric Power Research Inst., Palo Alto, CA
13	2:3874	Electric Power Research Inst., Palo Alto, CA
EPRI-SR-		
14	2:4323	NTIS, $4.50
ERDA-		
76-29	2:3312	Dep. NTIS, $7.50
76-73	2:4341	Dep. NTIS, $4.00
ERDA/JPL/954363-		
76/1	2:2600	Dep. NTIS, $4.00
ERDA/JPL/954372-		
76/2	2:2601	Dep. NTIS, $5.00
ERDA/JPL/954373-		
76/3	2:2602	Dep. NTIS, $4.00
ERDA-tr-		
125	2:4189	Dep. NTIS, $9.25
143	2:2627	Dep. NTIS, $3.50
153	2:2378	Dep. NTIS, $3.50
154	2:2379	Dep. NTIS, $3.50
161	2:3849	Dep. NTIS, $3.50
163	2:2367	Dep. NTIS, $3.50
ERI-		
75044	2:4280	Dep. NTIS, $3.50
EUR-		
5205d	2:2821	*See* KFK-1275/2
EUR-CEA-FC-		
772	2:3667	INIS
773	2:4234	INIS
EURFNR-		
1274	2:3154	
1285	2:3483	Dep. NTIS, $4.50
1301	2:3666	Dep. NTIS, $6.75
1323	2:2819	AT
1333	2:3126	Dep. NTIS (US Sales Only), $4.00
1336	2:4135	Dep. NTIS, $12.50
1337	2:4122	Dep. NTIS (US Sales Only), $4.00
FE-		
1220-12	2:2265	Dep. NTIS, $3.50
1505-6	2:2278	Dep. NTIS, $4.00
1514-47	2:2279	Dep. NTIS, $4.50
1521-20	2:2280	Dep. NTIS, $4.50
1544-22	2:2321	Dep. NTIS, $5.50
1770-12	2:2281	Dep. NTIS, $4.00
1794-13	2:2282	Dep. NTIS, $4.00
2000-3	2:2283	Dep. NTIS, $4.50
2003-12	2:2322	Dep. NTIS, $4.00
2011-3	2:2323	Dep. NTIS, $4.00
2027-1	2:2264	Dep. NTIS, $10.50
2028-2	2:2269	Dep. NTIS, $5.00
2030-3	2:2284	Dep. NTIS, $7.50
2203-8	2:2285	Dep. NTIS, $5.50
2231-1	2:2286	Dep. NTIS, $3.50
2233-1	2:2330	Dep. NTIS, $3.50
2307-5	2:2324	Dep. NTIS, $4.00
FERMILAB-Conf-		
76/30-THY	2:4102	Dep. NTIS, $3.50
76/50-THY	2:4105	Dep. NTIS, $4.00
FIND-STN-		
50546	2:2902	Dep. NTIS, $3.50
FRNC-R-		
37	2:2932	INIS
FRNC-TH-		
539	2:3127	INIS
FWC/FWEC/GQ-		
06	2:2280	*See* FE-1521-20
GA-A-		
12710	2:3088	Dep. NTIS, $5.50
13825	2:2765	Dep. NTIS, $4.00
13933	2:3128	General Atomic Co., San Diego, CA
13950	2:2766	Dep. NTIS, $12.75
GA-LTR-		
104	2:3128	*See* GA-A-13933
GAT-E-		
202	2:3386	Dep. NTIS, $3.50
GEAP-		
11367	2:2706	Dep. NTIS, $6.00
21214	2:3129	NTIS, $6.00

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GERHTR-		
145	2:2471	Dep. NTIS, $4.50
149	2:2499	Dep. NTIS (US Sales Only), $3.50
GJBX-		
27-76	2:2430	*See* DPST-76-138-2
36(76)	2:2435	*See* K-TL-602
46-76	2:2431	*See* DPST-76-141-2
GSCan-P-		
74-35	2:2444	INIS
75-26	2:2432	INIS
75-26	2:2434	INIS
75-26	2:2433	INIS
HEDL-FCD-		
188	2:3089	AT
HEDL-SA-		
75-48	2:3090	Dep. NTIS, $5.00
987	2:3091	Dep. NTIS, $4.00
HEDL-TME-		
75-147	2:3130	AT
HMI-B-		
172	2:3344	INIS
HW-		
73456	2:2500	Dep. NTIS, $3.50
ICP-		
1094	2:3575	Dep. NTIS, $3.50
IKE-		
6-64E	2:2964	INIS
INIS-mf-		
2085	2:2949	INIS
2086	2:3131	INIS
3039	2:2486	INIS
3053	2:2487	INIS
3067	2:4339	INIS
3070	2:3770	INIS
3071	2:2421	INIS
IPF-		
74-9	2:4245	INIS
74-12	2:3668	INIS
IPP-		
4/129	2:4264	INIS
ITN-		
101-1975	2:2965	INIS
JAERI-M-		
6096	2:4253	INIS
JAPFNR-		
225	2:2820	Dep. NTIS (US Sales Only), $6.00
JPNRSR-		
35	2:3149	NTIS
Juel-		
1191	2:2955	INIS
1194	2:3537	INIS
1197	2:3092	INIS
1198	2:2767	INIS
1201	2:2768	INIS
1203	2:2933	INIS
1215	2:2769	INIS
1220	2:3080	INIS
1230	2:2934	INIS
K/GD-		
1483	2:3771	Dep. NTIS, $3.50
K-TL-		
602	2:2435	Dep. NTIS, $5.50
KFK-		
1275/2	2:2821	INIS
1901	2:3132	INIS
2091	2:3044	INIS
2129	2:4122	*See* EURFNR-1337
2153	2:3081	INIS
2162	2:2501	INIS
2170	2:2520	INIS
2195	2:3875	INIS
2195	2:3876	INIS
2217	2:3133	INIS
2221	2:2819	*See* EURFNR-1323
2241	2:3126	*See* EURFNR-1333
LA-		
6293-PR	2:3661	Dep. NTIS, $3.50
6344-MS	2:4311	Dep. NTIS, $6.75
6374—MS	2:3720	Dep. NTIS, $4.00
6389-MS	2:4127	Dep. NTIS, $4.50
6391-MS	2:4254	Dep. NTIS, $3.50
6451-PR	2:3897	Dep. NTIS, $3.50
LA-NUREG-		
6427-PR	2:4015	Dep. NTIS, $3.50
LA-tr-		
76-16	2:3729	Dep. NTIS, $3.50
76-17	2:3731	Dep. NTIS, $3.50
76-19	2:4178	Dep. NTIS, $4.50
LA-UR-		
75-2353	2:3506	Dep. NTIS, $3.50
76-360	2:3454	Dep. NTIS, $3.50
76-494	2:4033	Dep. NTIS, $3.50
76-499	2:2452	Dep. NTIS, $3.50
76-972	2:4036	Dep. NTIS, $4.00
76-998	2:2900	Dep. NTIS, $3.50
76-1068	2:3797	Dep. NTIS, $3.50
76-1310	2:2548	Dep. NTIS, $4.00
76-1315	2:4046	Dep. NTIS, $3.50
76-1328	2:3781	Dep. NTIS, $3.50
76-1425	2:3782	Dep. NTIS, $4.00
76-1426	2:3783	Dep. NTIS, $4.00
76-1445	2:3780	Dep. NTIS, $3.50
76-1647	2:2453	Dep. NTIS, $3.50
76-1701	2:3664	Dep. NTIS, $3.50
76-1718	2:3992	Dep. NTIS, $3.50
76-1722	2:2521	Dep. NTIS, $3.50
LAMS-NUREG-		
6231	2:2770	Dep. NTIS, $3.50
LBL-		
2966	2:2639	NTIS, $4.00
3885	2:4214	*See* RLO-2041-137
4471	2:4312	Dep. NTIS, $3.50
4499	2:3641	Dep. NTIS, $5.00
4574	2:3474	Dep. NTIS, $4.00
4805	2:3642	Dep. NTIS, $3.50
4824	2:3738	Dep. NTIS, $3.50
5017	2:3562	Dep. NTIS, $3.50
5114	2:4047	Dep. NTIS, $3.50
5121	2:3455	Dep. NTIS, $3.50
5125	2:3453	Dep. NTIS, $4.50
5173	2:3525	Dep. NTIS, $4.00
5186	2:3295	Dep. NTIS, $3.50
5196	2:3590	Dep. NTIS, $5.00
5207	2:3591	Dep. NTIS, $5.00
5317	2:3879	Dep. NTIS, $3.50
LERC/RI-		
76/2	2:2287	Dep. NTIS, $4.00
LIB/Trans-		
554	2:2956	Dep. NTIS (US Sales Only), $3.50
MATT-		
1254	2:4269	Dep. NTIS, $4.00
1262	2:4228	Dep. NTIS, $4.00
1264	2:4270	Dep. NTIS, $3.50
1266	2:4271	Dep. NTIS, $4.50
MERC/TPR-		
76/2	2:2381	Dep. NTIS, $3.50
MHSMP-		
75-24H	2:3784	Dep. NTIS, $3.50
75-24I	2:3785	Dep. NTIS, $3.50
76-12	2:3643	Dep. NTIS, $3.50
MIT-		
2793-2	2:3605	Dep. NTIS, $3.50
MLM-		
2309	2:2563	Dep. NTIS, $3.50
NASA-TM-X-		
71547	2:3433	NTIS
NBS-SPEC.PUBL-		
409	2:2374	GPO, $3.90
NCSR-R-		
4	2:2993	INIS
5	2:2994	INIS
NEANDC(E)-		
163-U	2:2822	INIS
NEDM-		
14082	2:2823	AT
NEDO-		
13442P-01	2:3134	Dep. NTIS, $5.00
20939	2:2707	Dep. NTIS, $4.00
21021	2:3056	General Electric Co., San Jose, CA
NP-		
20828	2:2575	
20867	2:2345	Southern Illinois Univ., Carbondale
20881	2:2738	NRC

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20960	2:3414	Society of Automotive Engineers, Inc. (Jan 1975).
20989	2:3135	Dep. NTIS, $3.50
20991	2:2924	GPO, $13.00
20998	2:2671	San Diego Gas and Electric Co., CA
21008	2:3317	TIC
21105	2:3136	Detroit Edison Co., MI
21115	2:3137	NTIS
21124	2:2577	University of Oregon (1975).
21125	2:2615	Univ. of Oregon, Eugene
21131	2:3821	Council on Environmental Quality, Washington, DC
21143	2:3379	Dep. NTIS (US Sales Only), $5.00
NR-tr-		
001	2:3251	NTIS, $7.75
002	2:3035	NTIS, $7.50
NRCI-		
76/6	2:2903	NTIS
NRL-Report-		
8004	2:3475	Naval Research Lab., Washington, DC
NSF-RA-N-		
74-242	2:3345	Dep. NTIS, $3.50
74-246	2:2628	Dep. NTIS, $4.50
NSF/RANN/SE/GI-		
39456/FR/75/3	2:2606	Dep. NTIS, $11.00
NTISUB/B/142-		
76/006	2:2903	*See* NRCI-76/6
NUREG-		
0078	2:3138	NTIS, $4.50
0081	2:2708	NTIS, $4.50
0083	2:3139	NTIS, $5.50
0085	2:3045	NTIS, $5.00
0099	2:2904	NTIS, $5.00
0106(Vol.1-2)	2:3140	NTIS, $9.00
NUREG/PRDI-		
76/7	2:2905	TIC, $3.50
76/8	2:2906	TIC, $3.50
NVO-		
174(Rev.1)	2:3791	Dep. NTIS, $4.50
269-27	2:3842	Dep. NTIS, $4.50
409-3	2:3850	Dep. NTIS, $4.00
410-35	2:3786	Dep. NTIS, $3.50
NYO-		
3425-12	2:3798	Dep. NTIS, $6.00
OITS-		
75-12	2:4118	*See* RLO-2041-140
75-35	2:4107	*See* RLO-2041-150
ONERA-NT-		
216	2:3669	INIS
ORNL-		
5097	2:3070	Dep. NTIS, $5.50
5136	2:3476	AT
5137	2:4123	Dep. NTIS, $8.00
5169	2:3815	Dep. NTIS, $5.00
5174	2:3477	Dep. NTIS, $4.00
ORNL/CSD-		
3	2:3914	Dep. NTIS, $3.50
ORNL/CSD/TM-		
10	2:4346	Dep. NTIS, $4.00
12	2:4347	Dep. NTIS, $4.00
ORNL-MIT-		
152	2:2502	Dep. NTIS, $4.00
ORNL/NUREG/TM-		
22	2:3071	Dep. NTIS, $6.00
25	2:3141	Dep. NTIS, $4.50
42	2:3142	Dep. NTIS, $3.50
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5267	2:4272	Dep. NTIS, $4.00
5284	2:2543	Dep. NTIS, $5.00
5300	2:3558	Dep. NTIS, $6.00
5308	2:2771	Dep. NTIS, $4.00
5453	2:3975	Dep. NTIS, $4.00
5454	2:3976	Dep. NTIS, $4.00
5477	2:2467	AT
5495	2:3645	Dep. NTIS, $6.00
5500	2:3607	Dep. NTIS, $4.50
5502	2:2772	Dep. NTIS, $4.50
5543	2:3552	Dep. NTIS, $4.00
5545	2:2522	Dep. NTIS, $5.00
5553	2:3478	AT
5579	2:2457	Dep. NTIS, $4.00
5595	2:2325	Dep. NTIS, $4.00
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4111	2:4006	Dep. NTIS, $3.50
4126	2:3839	Dep. NTIS, $3.50
4137	2:4310	Dep. NTIS, $3.50
4160	2:4000	Dep. NTIS, $3.50
4177	2:2777	Dep. NTIS, $3.50
4184	2:3593	Dep. NTIS, $3.50
4187	2:4313	Dep. NTIS, $3.50
4191(DRAFT)	2:3865	Dep. NTIS, $3.50
4204	2:4005	Dep. NTIS, $3.50
4209	2:3490	Dep. NTIS, $3.50
4212	2:3573	Dep. NTIS, $3.50
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2408-113	2:4050	Dep. NTIS, $3.50
2504-247	2:4066	Dep. NTIS, $4.50
3443-61	2:4348	Dep. NTIS, $4.00
3624-16	2:4132	Dep. NTIS, $4.50
3631-6	2:3963	Dep. NTIS, $3.50
3924-23	2:4131	Dep. NTIS, $4.50
3992-255	2:4119	Dep. NTIS, $3.50
3992-262	2:4032	Dep. NTIS, $3.50
3992-267	2:4173	Dep. NTIS, $4.50
3992-276	2:4114	Dep. NTIS, $3.50
4322-19	2:4137	Dep. NTIS, $4.00
4927-76/1	2:2622	Dep. NTIS, $3.50
4958-4	2:3143	Dep. NTIS, $4.50
5126-2	2:4130	Dep. NTIS, $4.00
ORP/CSD-		
75-3	2:3993	Environmental Protection Agency, Washington, DC
75-4	2:3994	Environmental Protection Agency, Washington, DC
PATENTS-AU-		
A463432/B/	2:3050	
A463611/B/	2:2440	
A464698/B/	2:2456	
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A74/72674/A/	2:2505	
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2037030/C/	2:2450	
2150181/A/	2:2449	
2,341,063/C/	2:2780	
2341678/A/	2:3048	
2,347,817/A/	2:2778	
2361791/A/	2:2507	
2,363,845/A/	2:2845	
2,364,349/A/	2:2846	
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2229010/A/	2:3005	
2,235,606/D	2:2672	
2,238,217/A/	2:2742	
2,238,667/E/	2:3526	
2,238,995/A/	2:2840	
2,241,759/A/	2:2743	
2,241,849/A/	2:2831	
2,242,631/A/	2:2832	
2,242,690/A/	2:3000	
2,242,747/E/	2:2833	
2,242,748/A/	2:2834	
2,242,750/A/	2:2998	
2,242,897/D/	2:2999	
2243012/A/	2:2458	
2243148/A/	2:2468	
2243494/A/	2:2836	
2243495/A/	2:2710	
2243496/A/	2:2711	
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2245942/E/	2:3006	
2245962/A/	2:2438	
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2246850/A/	2:2838	
2246941/A/	2:2839	
2246942/A/	2:2837	
PATENTS-GB-		
1402936/B/	2:2847	
1,411,375/B/	2:2781	
1,413,304/B/	2:2849	
1,413,505/B/	2:2848	
1,414,286/B/	2:3029	
1,414,305/B/	2:2718	
1416184/B/	2:3030	
1416333/B/	2:2850	
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A586,460	2:3710	
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3,846,096	2:2570	
3,911,287	2:2646	
3,912,937	2:2644	
3,912,938	2:2647	
3,928,538	2:2446	
3,928,771	2:2645	
3,928,967	2:2648	
3,929,602	2:3631	
3,929,961	2:2473	
3,931,523	2:3747	
3,932,197	2:3369	
3,932,594	2:3527	
3,932,752	2:3748	
3,932,758	2:3760	
3,932,834	2:4025	
3,933,530	2:3768	
3,934,143	2:3749	
3,934,165	2:3750	
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3,935,028	2:3366	
3,935,029	2:3368	
3,935,031	2:3373	
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3,937,961	2:3754	
3,937,964	2:3753	
3,939,771	2:4027	
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3,940,627	2:3755	
3,943,436	2:4029	
3,946,356	2:4031	
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3,947,255	2:2574	
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3,948,224	2:3410	
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3,948,233	2:3411	
3,948,235	2:3396	
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3,965,434	2:3733	
3,965,471	2:3769	
3,965,680	2:3404	
3,965,681	2:3405	
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3,966,443	2:3425	
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3,969,893	2:3442	
3,969,894	2:3430	
3,970,052	2:3441	
3,970,054	2:3408	
3,970,061	2:3431	
3,970,140	2:2653	
3,970,247	2:3409	
3,970,852	2:3758	
AB492,902	2:4028	
AB513,791	2:2634	
AB521,985	2:2571	
PB-		
244649	2:4323	*See* EPRI-SR-14
248292	2:3377	NTIS
PEM-		
51	2:4349	Dep. NTIS, $4.50
PERC-		
0060-4	2:2572	Dep. NTIS, $3.50
PNC-N-		
251-74-29	2:3144	INIS
341-75-10	2:2790	INIS
PNE-R-		
67(Rev.1)	2:3791	*See* NVO-174(Rev.1)
PRNC-		
202	2:3851	Dep. NTIS, $9.00
PTB-Me-		
7	2:2377	Dep. NTIS (US Sales Only), $5.50
PWA-		
1/75	2:2501	*See* KFK-2162
10/75	2:2520	*See* KFK-2170
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76-1	2:3317	*See* NP-21008
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3239	2:2739	INIS
3252	2:2824	INIS
3263	2:4281	INIS
3352	2:2825	INIS
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3-16T(4-76)	2:2995	RSO
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76-81	2:3332	
76-93	2:2826	General Accounting Office, Washington, DC
76-107	2:2666	General Accounting Office, Washington, DC
76-110	2:2447	General Accounting Office, Washington, DC
REG/G-		
1.52(Rev.1)(7-76)	2:2930	NUREG
1.64(Rev.2)(6-76)	2:2926	NUREG

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1.84(Rev.4)(8-76)	2:2931	NUREG
1.96(Rev.1)(6-76)	2:2925	NUREG
1.108(8-76)	2:2908	NUREG
1.118(6-76)	2:2909	NUREG
1.119(06-76)	2:2910	NUREG
2.4(7-76)	2:2911	NUREG
4.2(Rev.2)(7-76)	2:2904	*See* NUREG-0099
5.57(6-76)	2:2554	NUREG
10.3(7-76)	2:2555	NUREG
185(Rev.7)(8-76)	2:2912	NUREG
RFP-NUREG-		
2517	2:2477	Dep. NTIS, $4.00
RLO-		
1388-297	2:4128	Dep. NTIS, $4.00
1388-670	2:4171	Dep. NTIS, $4.00
2041-125	2:4121	Dep. NTIS, $3.50
2041-129	2:4116	Dep. NTIS, $4.00
2041-130	2:4117	Dep. NTIS, $3.50
2041-131	2:4108	Dep. NTIS, $3.50
2041-132	2:4115	Dep. NTIS, $3.50
2041-136	2:4113	Dep. NTIS, $3.50
2041-137	2:4214	Dep. NTIS, $3.50
2041-140	2:4118	Dep. NTIS, $4.00
2041-143	2:3727	Dep. NTIS, $3.50
2041-144	2:3728	Dep. NTIS, $3.50
2041-150	2:4107	Dep. NTIS, $3.50
2221-T2-23	2:3948	Dep. NTIS, $3.50
2225-T18-18	2:3869	Dep. NTIS, $4.50
2225-T19-34	2:3915	Dep. NTIS, $3.50
2225-T19-35	2:3942	Dep. NTIS, $3.50
2225-T25-14	2:3855	Dep. NTIS, $4.00
2225-T28-12	2:4334	Dep. NTIS, $4.50
2225-T34-5	2:3057	Dep. NTIS, $3.50
2225-T34-6	2:3058	Dep. NTIS, $3.50
2225-T40-1	2:3860	Dep. NTIS, $4.00
2227-T12-50	2:3861	Dep. NTIS, $3.50
2227-T12-55	2:3856	Dep. NTIS, $7.75
2227-T12-56	2:4010	Dep. NTIS, $3.50
2229-T10-1	2:2373	Dep. NTIS, $3.50
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1111-76-2	2:2607	Dep. NTIS, $5.00
SAN/1111-		
75/1	2:2608	Dep. NTIS, $5.00
SAND-		
75-6189	2:3507	Dep. NTIS, $3.50
76-533	2:2380	Dep. NTIS, $3.50
76-0077	2:2523	Dep. NTIS, $4.00
76-0096	2:3646	Dep. NTIS, $4.50
76-0135	2:3647	Dep. NTIS, $5.00
76-0139	2:3670	Dep. NTIS, $9.00
76-0151	2:3787	Dep. NTIS, $3.50
76-0231	2:3955	Dep. NTIS, $4.50
76-0254	2:3563	Dep. NTIS, $5.00
76-0277	2:2656	Dep. NTIS, $3.50
76-0411	2:2576	Dep. NTIS, $4.00
76-5157	2:3648	Dep. NTIS, $4.00
76-5231	2:3662	Dep. NTIS, $3.50
76-5292	2:3456	Dep. NTIS, $3.70
76-5319	2:2524	Dep. NTIS, $3.50
76-5363	2:3665	Dep. NTIS, $3.50
76-5653	2:2525	Dep. NTIS, $4.00
76-5721	2:3457	Dep. NTIS, $3.50
76-5724A	2:4324	Dep. NTIS, $3.50
76-5732	2:3788	Dep. NTIS, $4.00
76-5759	2:2603	Dep. NTIS, $3.50
76-6029	2:3533	Dep. NTIS, $4.00
76-8010	2:3792	Dep. NTIS, $4.50
76-8033	2:3816	Dep. NTIS, $3.50
76-8232	2:3707	Dep. NTIS, $6.75
SGAE-		
2518	2:2503	INIS
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201-76-03	2:2820	*See* JAPFNR-225
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SRD-R-		
50(Pt.1)	2:3145	Dep. NTIS (US Sales Only), $4.00
SREL-		
6	2:3862	Dep. NTIS, $5.00
SRO-		
641-23	2:3848	Dep. NTIS, $3.50
777-1(Pts.1-3)	2:3863	Dep. NTIS, $6.00
854-7	2:3572	Dep. NTIS, $4.00
869-1	2:3877	Dep. NTIS, $4.00
SSS-R-		
76-2909	2:2281	*See* FE-1770-12
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10/174	2:2436	IAEA, $4.00
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4202/4203-54-76	2:3365	Dep. NTIS, $3.50
TID-		
3311-S7	2:2504	Dep. NTIS, $9.75
3362	2:3146	Dep. NTIS, $3.50
27098	2:3799	Dep. NTIS, $4.00
27118	2:2544	Dep. NTIS, $9.25
27127	2:2409	Dep. NTIS, $5.00
27131	2:4152	Dep. NTIS, $6.00
27135	2:2437	Alaska Division of Geological and Geophysical Surveys, P.O. Box 80007, College, Alaska 99701, $10.00
TID/BERC-		
20	2:2573	TIC
37	2:2376	TIC
38	2:2355	TIC
41	2:2356	TIC
42	2:2357	TIC
45	2:2372	TIC
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2690(D)	2:2827	INIS
2716(D)	2:3059	INIS
2733(R)	2:2828	INIS
UCID-		
16949-76-1	2:3663	Dep. NTIS, $4.00
17111	2:3766	Dep. NTIS, $4.00
17155	2:3713	Dep. NTIS, $3.50
17159	2:3592	Dep. NTIS, $4.00
17173	2:3789	Dep. NTIS, $3.50
17179	2:4255	Dep. NTIS, $3.50
17199	2:3541	Dep. NTIS, $3.50
17205-1	2:3852	Dep. NTIS, $3.50
17241	2:3649	Dep. NTIS, $4.50
17247	2:3479	Dep. NTIS, $3.50
UCLA-		
12-1055	2:3843	Dep. NTIS, $3.50
12-1056	2:3844	Dep. NTIS, $3.50
UCRL-		
13647-2	2:3671	Dep. NTIS, $4.00
13649	2:3672	Dep. NTIS, $3.50
13686	2:3673	Dep. NTIS, $4.00
50026-76-2	2:2288	Dep. NTIS, $4.00
51951	2:3674	Dep. NTIS, $4.00
51957(Rev.1)	2:2412	Dep. NTIS, $3.50
52000-76-7	2:3375	Dep. NTIS, $3.50
52035(Pt.2)	2:2289	Dep. NTIS, $3.50
52041	2:3446	Dep. NTIS, $4.00
52046	2:3577	Dep. NTIS, $4.00
52047	2:3561	Dep. NTIS, $4.00
52068	2:2556	Dep. NTIS, $4.50
52074	2:3817	Dep. NTIS, $4.00
52086	2:3554	Dep. NTIS, $3.50
52087	2:3772	Dep. NTIS, $3.50
77064	2:4325	Dep. NTIS, $4.00
77076	2:4235	Dep. NTIS, $3.50
77246	2:3675	Dep. NTIS, $3.50
77627(Rev.1)	2:2290	Dep. NTIS, $4.00
77640	2:4246	Dep. NTIS, $4.00
77658	2:4037	Dep. NTIS, $3.50
77734	2:4326	Dep. NTIS, $3.50
77839	2:4182	Dep. NTIS, $3.50
77906	2:2623	Dep. NTIS, $3.50
78037	2:3809	Dep. NTIS, $3.50
78085	2:3253	Dep. NTIS, $3.50
78092	2:3810	Dep. NTIS, $3.50
78126	2:3147	Dep. NTIS, $3.50
78280	2:3388	Dep. NTIS, $3.50
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78302	2:2291	Dep. NTIS, $3.50
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78344	2:4151	Dep. NTIS, $3.50
78397	2:3899	Dep. NTIS, $4.00
78409	2:3995	Dep. NTIS, $3.50
78411	2:4327	Dep. NTIS, $3.50
78412	2:3900	Dep. NTIS, $3.50
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1525	2:2667	Dep. NTIS, $4.00
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11101	2:2293	Dep. NTIS, $4.50
11107	2:2294	Dep. NTIS, $5.00
11109	2:2346	Dep. NTIS, $3.50
11113	2:2296	Dep. NTIS, $3.50
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11121	2:4053	Dep. NTIS, $4.00
11122	2:4222	Dep. NTIS, $4.00
11124	2:2297	Dep. NTIS, $4.50
11131	2:2295	Dep. NTIS, $3.50
11137	2:2299	Dep. NTIS, $3.50
11139	2:2298	Dep. NTIS, $3.50
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